THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

[Registered as a Newspaper.]

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COMPLETION of the FIRST VOLUME
OF
KING'S TREATISE
ON THE
SCIENCE AND PRACTICE
OF THE
MANUFACTURE
AND DISTRIBUTION
OF
COAL GAS.

[*For detailed announcement, see page* 782.]

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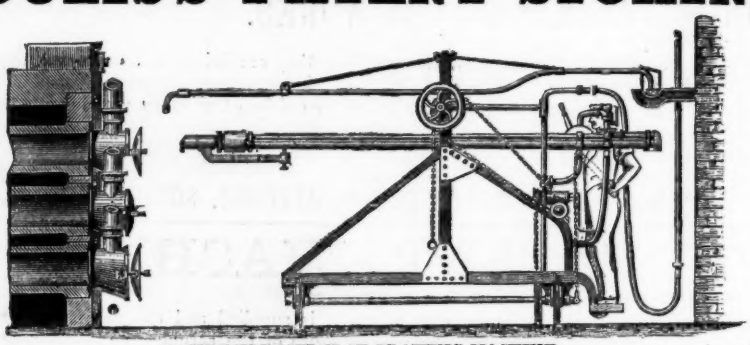
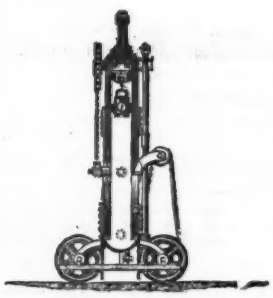


SIDE ELEVATION OF DRAWING MACHINE.



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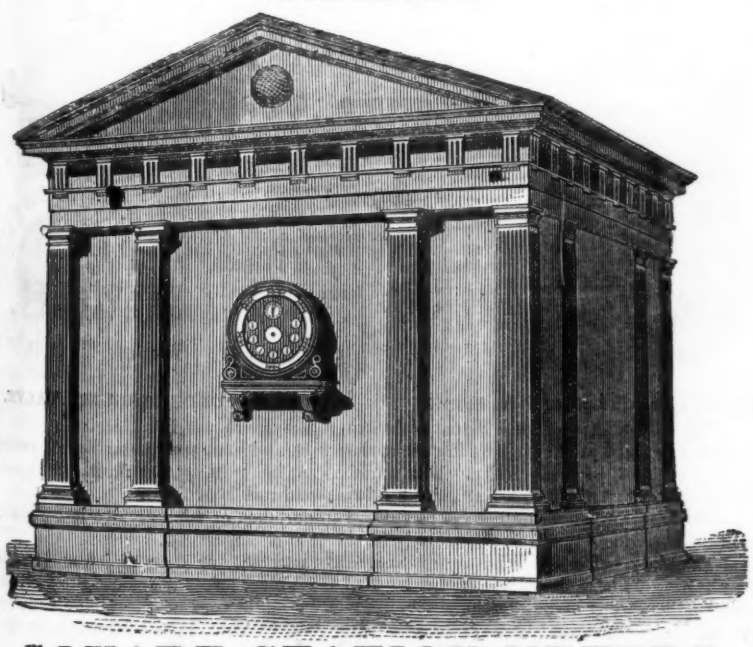

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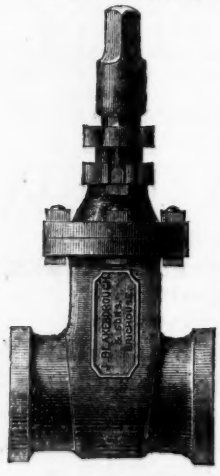

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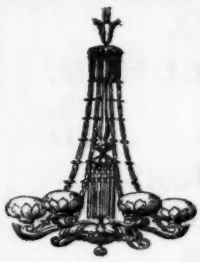

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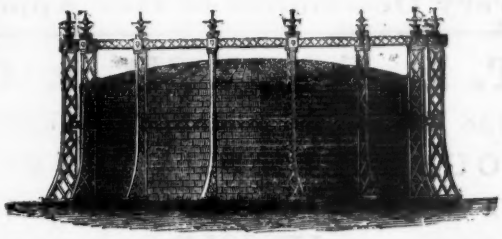

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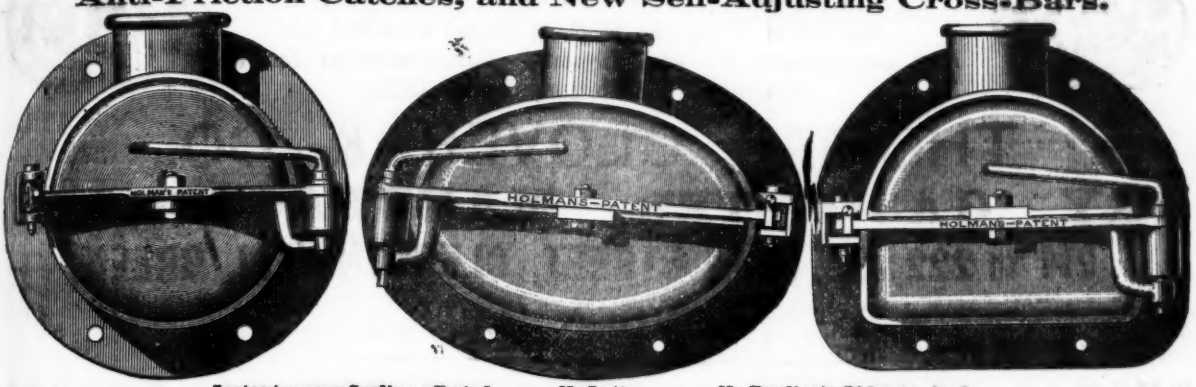
WITH HOLMAN'S PATENT ECCENTRIC FASTENINGS,
Anti-Friction Catches, and New Self-Adjusting Cross-Bars.



Instantaneous Sealing effected. No Luting. No Duplicate Lids required.
Holman's New Self-Sustaining Cross-Bar ensures freedom of Joint, and maintains parallel position of the Lids.

Since their introduction in 1869, these Patent Retort-Lids have been thoroughly tested, being now in use in nearly all the principal Gas-Works in London and the Provinces.

T. B. and H. are now making the "Morton's Self-Sealing Lid" of the SAME FORM OR SECTION AS THE RETORT (see Illustrations above), as well as bringing the Mouthpiece from the D or Oval at back to Circular in front, as heretofore.

D and Oval Morton's Lids are working satisfactorily both in this country, on the Continent, and in the United States of America. Among others they have been adopted by the following Gas-Works:—

The Gaslight Company's Works, Fulham; Ditto, Bromley-by-Bow; Ditto, King's Cross; Ditto, Shoreditch.
And also in the Gas-Works at Richmond, Maidstone, Gloucester, Glasgow, Portsea, Roubaix (France), The Hague (Holland

HUNT'S PATENT EQUILIBRIUM GAS-GOVERNOR.

In this Governor a Throttle-Valve is substituted for the ordinary suspended Cone, all external communications being avoided by placing the Lever or Radius Arm (shown in the drawing) inside the Valve-Chamber upon the Disc. The Disc is carried upon steel centres, upon which it is accurately balanced and turns freely. The friction in working is thereby reduced to a minimum. This Governor is extremely sensitive to alterations of inlet or outlet pressure, and renders a large actuating holder unnecessary.

The principal advantages of this arrangement over the ordinary form of Governor are as follows:—

Its sensitive action prevents oscillation.

It is self-adjusting—*i.e.*, it maintains a steady pressure under variations of inlet pressure or a fluctuating consumption.

The inlet to Gasholder being contracted to the smallest possible dimensions, all danger from leakage through insufficiency of seal, tilting, &c., is entirely avoided.

The valve portion being separate from the holder, it can be handled and fixed like an ordinary Slide-Valve direct in the main; and the holder can be placed at an convenient distance immediately above it. The cost is thus materially reduced, and the inconvenience of heavy lifts done away with.

There are no working parts likely to get out of order.

These Governors have been adopted by many leading Gas Companies, among whom are the following:—

The Gaslight and Coke Co. (9), The London Gas Co. (3), and at Abergavenny, Arundel, Birmingham, Cannes (France), Devonport, Dursley, Exeter, Guernsey, Halesowen, Mentone (France), Monmouth, Newcastle-on-Tyne, Oxford, Plymouth, Rochdale, Windsor, &c.

TESTIMONIAL.

The Gaslight and Coke Company,
9, Water Street, New Bridge Street,
Blackfriars, E.C., Feb. 27, 1875.

MESSRS. TANGYE BROTHERS AND HOLMAN.

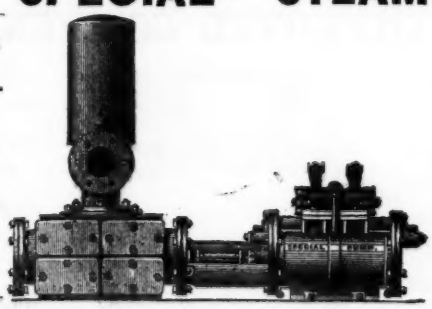
Gentlemen,—The two 24-inch and three 36-inch Hunt's Equilibrium Governors supplied by you, and fixed in the valve-rooms at Whitechapel, Goswell Road, and Blackfriars, are working very satisfactorily.

Yours truly,
(Signed) JOHN JOHNSON.

PRICES AND FULL PARTICULARS ON APPLICATION.

THE "SPECIAL" STEAM-PUMP.

Diameter of Steam Cylinder.	Diameter of Water Cylinder.	Length of Stroke.	Gallons of Water per Hour, Approximate.	Reduced Prices.
3	1½	9	450	£16
4	2	9	815	18
5*	2½	12	1,250*	20
5*	3	12	1,830*	22 10
4	4	12	3,250	25
6*	4	12	3,250*	30
5	5	12	5,070	32 10
7*	5	12	5,070*	40
6	6	12	7,330	40
8*	6	12	7,330*	50
7	7	12	9,750	50
10*	7	12	9,750*	65



In use in a Hundred Gas-Works in the United Kingdom for Pumping Ammoniacal Liquor, Water, or Tar.

Messrs. Burt, Boulton, and Haywood, Manufacturing Chemists, have over FORTY "Special" Steam-Pumps in use at their several large Tar-Works.

Two Hundred Sizes made. Those in Table opposite are the leading Sizes for use in Gas-Works and Chemical Works.

* These Sizes being usually selected for pumping Tar and Liquor, are always in stock, or nearly ready, fitted with all pump details in iron, and extra length distance-piece between steam and pump cylinder, at a small extra cost.

TANGYE'S HIGH-PRESSURE AND CONDENSING STEAM-ENGINES; CORNISH, VERTICAL, & TUBULAR BOILERS; HYDRAULIC AND SCREW LIFTING-JACKS, CRABS, PULLEY-BLOCKS, &c.

FULL PARTICULARS, ESTIMATES, CATALOGUES, ETC., ON APPLICATION.

London, 1851. New York. 1853. Paris, 1855. London. 1862.

Dublin, 1865.

The SIX MEDALS AWARDED to THOMAS GLOVER for

PATENT DRY GAS-METERS,

The latter being the Highest Medal awarded for Dry Gas-Meters by the Imperial Commissioners for the Universal Exhibition, Paris, 1867.

Paris, 1867.

THOMAS GLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

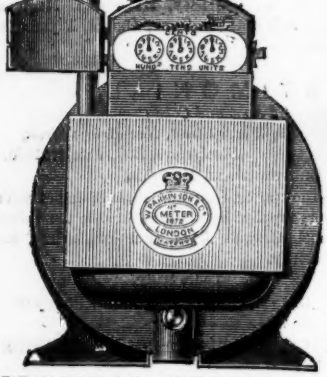
214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

LONDON, E.C.

THOMAS GLOVER & CO.'S PATENT DRY GAS-METERS,

1st, Are a remedy for all the defects of Wet Meters;
2nd, Are suitable for all climates, whether hot or cold;
3rd, Incur no loss of Gas by evaporation;
4th, Cannot become fixed by frost, however severe;
5th, Are the most accurate and unvarying measurers of Gas;
6th, Prevent jumping or unexpected extinction of the Lights;
7th, May be fixed either above or below the level of the Lights;
8th, Cannot be tampered with, without visibly damaging the outer case;
9th, Will last much longer than Wet Meters;
10th, Will not cost more than one-half for repair that Wet or Water Meters do;
Are upheld for five years without charge.

WILLIAM PARKINSON AND CO.,



(ESTABLISHED 1816,)

MANUFACTURERS OF

WET & DRY METERS,

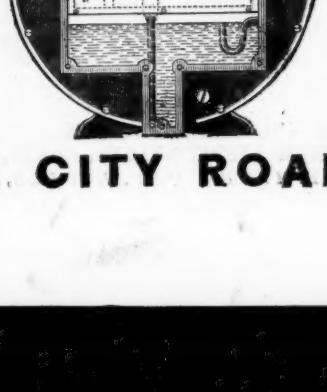
STATION-METERS & GOVERNORS,

EXHAUSTER REGULATORS,

PRESSURE REGISTERS, EXPERIMENTAL APPARATUS, GAUGES, WATER-METERS, &c.

HUNT'S PATENT IMPROVED COMPENSATING METER.

In this Meter, the action of the measuring-drum is reversed. By this arrangement an improvement is effected in the registration at high speeds, which, in many tests, has not varied from the smallest light to three times the capacity of the meter. It works equally well under all pressures. The range of error between the high and low line is much smaller than that allowed by the "Sale of Gas Act."



The Meter has been critically tested, and most favourably reported upon by official Meter Inspectors in London and Birmingham.

W. PARKINSON and CO. have made arrangements for the manufacture of these Meters, both in tin and cast-iron cases, and for the alteration of old ones to this principle, which is confidently recommended as possessing every quality that can be desired by Gas Companies, Corporations, or Private Consumers.

COTTAGE LANE, CITY ROAD, LONDON, E.C.

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TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion, must be authenticated by the name and address of the writer; not necessarily for publication, but as a guarantee of good faith.

W. C. *writes that the paragraph in our last issue (page 686) relative to a Local Government Board Inquiry at Briton Ferry, upon an application of the Local Board to borrow £4035 for gas-works extensions, is incorrect in stating that "it was supposed that the sum due to the bank could be included in the loan." Our correspondent says, "such a thing was never thought of." Several interesting facts in our correspondent's letter will have attention hereafter.*

G. Webster, Nottingham.—*Received, and shall have attention.*

R. O. P., Cheltenham.—*Your letter, which did not reach us till Monday morning, necessarily stands over till next week.*

T. T., West Hartlepool.—*Thanks; we are glad of the information, and shall publish it in due course.*

THE JOURNAL OF GAS LIGHTING,
WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, MAY 7, 1878.

Circular to Gas Companies.

It is an axiom in physics that large bodies move slowly. We are, therefore, not surprised that the Corporation of the City of London are making but small progress with the scheme for a complete Municipal Organization for the whole of the Metropolis. We care nothing about the authorship of the scheme, or its exact details; it is sufficient for us to know that a plan is under consideration at Guildhall, which promises to accomplish the results we desire so much to see achieved. The present time of the year brings to Committees a large amount of general business which must be cleared off; but when Members come back from their summer holidays, "like giants refreshed with new "wine," we may expect that some advance will be made in the constitution of a Metropolitan Municipality. We need not here again remark upon the importance it will have to Metropolitan Gas Companies. It is sufficient for us to say that serious consideration is being given to the formation of a Metropolitan Municipality which may possibly swallow up the Gas Companies. A word to the wise is all we need add.

Last night an experiment with the electric light was to have been made in the open space facing the Mansion House. At this moment we do not know whether any experiment has been made, or, if it has, what result has been obtained. Our readers know perfectly well that we entertain no objection to the employment of electricity for the public illumination of open places. In the instance now under notice we are not informed where the boiler and the dynamo-electric machine are to be placed. They may be located very properly in the kitchen of the Mansion House, the space of which will be better occupied than in the warming up of viands from Ring and Brymer's for the refection of hungry Common Councilmen. Next week we may, perhaps, have the opportunity of stating our opinion as to the result of the experiments made. To-day we have to observe reticence, not because we have much doubt about the matter, but because we wish only to report upon actual effects. We understand that the lantern is to be placed on the roof of the Mansion House, and we can easily comprehend the effects that will be produced. The *façade* of the Royal Exchange will be brilliantly illuminated, so also will the clock dial at the Globe Insurance Office; but the purblind wayfarers will run more risk than ever of being knocked down by omnibuses and Hansom cabs, as they attempt to make way over the dangerous crossings in this locality. We notice that certain contemporaries still talk about the generation of electricity by a moist battery. It is now over forty years since Liebig showed the absurdity of supposing that electricity generated in that way could possibly compete with gas, or, indeed, any other artificial mode of illumination then in use. We have now, however, a power which has entirely superseded the moist battery, and, so far, it may be said that we have a new antagonist to face. But we are not in the least afraid of it. It may light the open space in front of the Mansion House, and a dozen other spaces, which badly want better illumination, but every one will rejoice that the strongholds of the Gas Companies will still be safe. It must be very many years indeed, if it should ever occur, before electricity will be so distributed as to illuminate small areas with economy and comfort.

We have reason to believe that an attempt will shortly be made to introduce into this Metropolis what is known in New York, and other cities of the United States, as the Lowe system of gas-making. The process consists really in the manufacture of water gas, which is carburetted by means which have been more than once described in our columns. To-day we publish a report by Professor Würtz, on a gas of this description, and supplied by the Municipal Company in New York. The gas is undoubtedly of rich quality, being set down in the report, to which we alluded last week, as equal to twenty-two standard candles, while the price compares favourably with that of other Companies supplying New York with gas of inferior power. We doubt whether carburetted gas will succeed to any great extent in this country. Coal is cheap here, just as petroleum is in America, and low as the price of the carburetting material now is, it would soon be doubled by an increased demand. We do not look, therefore, to this novelty for any great advantage. It has undoubted merits, but is not exactly suited to our use. We have an abundance of cheap coal, which will last us for centuries, and we do not in the least expect to see the coal gas industry superseded, or even disturbed by these inventions.

The Town Council of Wigan, at a recent quarterly meeting, passed a resolution which practically absolves their Gas Committee from all blame in connection with the non-publication of the gas accounts. Seeing that the Committee have now resolved to comply with the law, we have nothing further to say but this: When writing last week of the general Acts of 1847 and 1871, we forgot, for the moment, the Consolidating Bill which is now before Parliament. On referring to this, we again find no distinction made between Companies and Corporations, but the provision is continued which makes it compulsory on all "undertakers" to furnish accounts in a form prescribed in a schedule. A certain latitude, as regards the form, is allowed, and this, we may take it, is a concession to Corporations, who need not supply some particulars which are stringently required from Companies.

The Leicester Corporation have just appointed Committees to manage their gas and water undertakings. Practising "self-"denial," as a member of the Corporation put it, they have limited the number of members on each Committee to thirteen, with, as a matter of course, the Mayor as an *ex-officio* member. We hardly understand the desire of so many gentlemen to serve on these Committees. They cannot be required, for if only half the number would really devote themselves to the business, it might be carried on with ease and regularity. What special inducement there is to become a Gas Committeeman, and why Town Councillors should be required to exercise "self-denial" in order to keep off the Committee, we do not understand. Vanity will, of course, induce men to undertake any amount of work, and we do not suppose that any substantial advantages can be derived from serving on the Gas Committee of the Corporation of Leicester. The number of members, however, does look to us excessive. Fifteen gentlemen manage the whole

business of the Chartered Gas Company, supplying more than half the Metropolis, with the utmost success.

The gas accounts of the Corporation of Rochdale have been recently issued, and show a very healthy state of affairs. The net profits appear to amount to £8622, but we are not told what is to be done with this surplus. The gas consumers of Rochdale and Leicester must wake up, or they will find themselves over-taxed. It is true that the Corporation of Rochdale have reduced the price of gas, but it is quite clear that it might be cheaper. Very favourable coal contracts, and, considering the times, a very fair sale for coke, should enable the Corporation to bring down the price of gas to a lower figure than at present. The sum realized for tar and ammoniacal liquor is too small, but we understand that the Corporation have a low contract, which is fast running out. Better prices will probably soon be obtained, and the consumers will then have another chance of a reduction.

A certain section of the inhabitants of Rotherham are dissatisfied with the present situation of the gas-works, and wish to have new ones erected on a more convenient site, and further removed from the centre of the town. A large majority of the Town Council have fallen in with this view of the case, and in all probability application will be made to Parliament next year for power to acquire another site, and to raise money for the construction of new works. The Rotherham undertaking, obtained under peculiar circumstances very much resembling compulsory purchase, has not, we believe, been particularly profitable to the Corporation; and, now that it is found necessary to erect new works, an additional load will be thrown upon the shoulders of the ratepayers. It is expected that the money brought by the sale of the site of the present works will do much to recoup the Corporation for the additional expenditure.

The Directors of the Hastings Gas Company have written a very polite letter to the Gas Consumers Association, showing the reasons why they cannot at the present moment reduce the price of gas. They point out the differences between the conditions of the supply of gas at Brighton and Hastings, and show how much more favourably the two Companies in the former place are situated. It was hardly necessary, we think, to take all this trouble, for every visitor to these two places, interested in gas-works, must see and know at once that gas could not be cheap at Hastings. As a matter of fact, we find the inhabitants do not much complain of the price. They would, of course, like to have gas cheaper, just as they would like to have butchers meat at a more reasonable price, but loud complaints we never met with. The Directors of the Company have now given their opponents an assurance that as soon as the just rights of their Shareholders permit, the price of gas will be lowered. Let the consumers be content with this. They have honourable men to deal with, and the promise made is certain to be kept.

The Brighton Corporation are about to make an effort to acquire the two gas undertakings which supply their limits. At the present moment, we believe, no negotiations have been entered upon, but between now and next November communications will be exchanged, and *pour-parlers* will take place, which are not unlikely to result, in the end, in the transference of the undertakings to the Corporation. We imagine that nothing like a compulsory purchase will be attempted. The Brighton undertakings are too valuable to be parted with on easy terms. Their market value would be very high, and perhaps when the Corporation come to consider the price they will have to pay, they may alter their minds as to the desirability of making the purchase.

The final meeting of the session 1877-78 of the North of England Association of Gas Managers was opened with an able address by Mr. W. J. Warner, of Shields. We are not inclined altogether to agree, however, with what the President said about papers and discussions. No doubt the preparation of a paper is a very useful exercise for a Manager; but Gas Engineers are not schoolboys. We expect them to bring to these meetings the results of experience—realized knowledge, as we may call it; and more of this may be conveyed in discussions than in a formal paper. In fact, the paper should be little more than a text upon which many members might preach. We are far from depreciating the practice of writing well-prepared essays, but the time Managers can give to these meetings is so extremely short, that long papers become a serious inconvenience. With all Mr. Warner says about the propriety of Gas Companies having a control over gas-fittings, we perfectly agree. It is due no less to the Consumer than to the Company, that supervision should be exercised, so that the one may obtain the utmost benefit from what he buys, and the other the greatest profit upon what he sells. Bad fittings and small pipes are the curses of the day. We do not speak of the artistic work, in which there is still much room for improvement, but of the actual means of distribution and consumption. Many improvements, however, may be expected as the knowledge of gas and its uses are made better known, at the exhibitions of which Mr. Warner was one of the first originators. The account of the electric light, given by Mr. Ford, of Stockton, is of much interest, for it shows how little gas has to fear from the competition of the new illuminant. It seems that in workshops, at all events, the two lights must be employed in conjunction; but then the use of the two lights together is very trying to the workman, whose eyes are at one moment dazzled by a brilliant glare, and at the next plunged into semi-darkness. At the last moment we find that we must defer publishing our report of the proceedings at the meeting, owing to the absence of one of the papers.

Water and Sanitary Notes.

We are very much surprised to hear that opposition to the Thirlmere scheme of the Manchester Corporation is to be carried to the House of Lords. We venture to predict that nothing will be gained by this action. The Report of the Commons Committee was so cogent and conclusive, that we have no fear that the decision arrived at will be reversed, or in the least interfered with. We presume that the opponents have still money in hand, and that they are anxious to expend it.

It would seem that an "informal" proposal has been made to Liverpool by the Corporation of Manchester, with a view to the disposal of some of the surplus water from Thirlmere to the former city. For some years to come Manchester will only require ten million gallons per day from that source, and power has been obtained to take fifty millions. Here, then, is a very large surplus which is available for the supply of many places, Liverpool among them. The proposal, it appears, does not find favour in the eyes of the Liverpool Water Committee, who seem bent on having a grand scheme of their own. It may be estimated that the wants of Liverpool will, in time, be very large, and may justify the Committee in going to an entirely independent source. An association with Manchester might, perhaps, stave off the difficulty for a quarter of a century; but then a pinch might come, and possibly it would be better to secure a full and independent supply by one outlay.

The Stockton and Middlesbrough Corporations have now ascertained the total cost of the water undertaking which they happily succeeded in purchasing. It stands as follows:—

Twenty-five years purchase of statutory dividends	£466,175
Mr. Higgins's award	213,802
Statutory and other debts	110,000
Total	£789,977

This, however, is by no means the whole cost, for various items, including the cost of arbitration, will bring up the amount to be paid by the Corporation to at least £850,000. As we have mentioned before, expense will not end here, for the Corporations are bound to go to the Balder and the Lune for a new and purer supply. When this supply is furnished, the ratepayers will know the full extent of their liabilities, and will probably for ever regret the day they entered upon the campaign against the Stockton and Middlesbrough Water Company. They might have had the works for little more than two-thirds of the money; but the Corporations would not come to terms with the Company. They made up their minds to carry things with a high hand, and they succeeded, and now have to pay the cost. The joint Water Board have sent precepts to the two Town Councils to pay forthwith their moiety of the purchase-money (£400,000), and the Councils are naturally exercised as to where it is to come from. The story of this purchase is very remarkable, and deserves the serious attention of all authorities who seek to acquire a Naboth's vineyard in the shape of gas and water undertakings. We have not space in our present number for the report of the Water Board, which is a very instructive document, and worthy the attention of ambitious Local Authorities in general, but shall publish it in our next.

Hadleigh Gas Company.—The report of the Directors shows that the profits for the year 1877 enable them to recommend a dividend at the rate of 7 per cent., and carry a balance to the reserve-fund.

Shoreham Water-Works Company.—The half yearly meeting of Shareholders was held at Brighton on the 27th ult.—Mr. W. Hall in the chair. The report of the Directors showed that there was a balance available for dividend of £267 9s. 7d., and they recommended the payment of a dividend of 2½ per cent., making, with the 3 per cent. declared in October last, 5½ per cent. for the year, carrying the sum of £30 to the reserve-fund, and leaving a balance of £49 19s. 7d. Additional services had been laid during the half year, producing an annual rental of about £35. The Directors stated that they were in negotiation with the owners of the Aldrington Estate for the extension of the Company's mains to that district.

A TREATISE ON THE SCIENCE AND PRACTICE OF THE MANUFACTURE AND DISTRIBUTION OF COAL GAS.

CLXIV.

PUBLIC LIGHTING (*continued*).

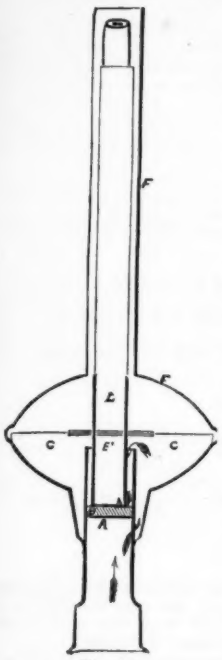

FIG. 45.

The apparatus shown in fig. 45, is the invention of Mr. W. Smith, and has the merit of simplicity to recommend it. The inlet-pipe, A, has a small cup, B, formed within it, containing mercury to seal the end of the burner-tube, D. This latter is secured to a flexible diaphragm, forming, with the body of the instrument, a chamber, C. The gas flows into this chamber through an orifice in the side of the inlet-pipe. F is a cover capable of being easily removed, standing a little above the top of the burner, to protect a small constant jet thereon from being extinguished. The gas for the supply of the constant jet is admitted through a hole, E, in the side of the burner-tube. The weight of the latter is so adjusted that, with the ordinary day pressure, the end of the tube remains immersed in the mercury, and the passage for the gas is consequently sealed; but as soon as the night pressure is put on, the diaphragm is raised, and the tube lifted clear of the mercury, admitting the gas to the burner in full force.

In looking at the apparatus, the principal objection that suggests itself is the difficulty of keeping the small hole, for the supply of the constant flame, clear of obstruction; and the jet itself will be extremely liable to extinction, owing to the limited quantity of gas supporting it, issuing from a comparatively large orifice. Altogether, the arrangement, though scarcely such as to ensure certainty of action when applied on an extended scale, suggests the possibility of achieving the end in view.

The automatic lighter, fig. 46, patented by Mr. W. A. Hunter in 1869, works by hydraulic power, and by one operation opens the stopcock, strikes a match, and lights the gas. A water service-pipe

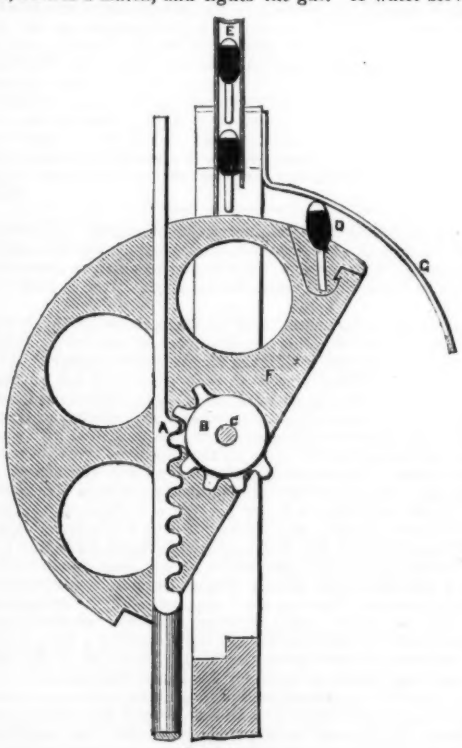

FIG. 46.

is laid from lamp to lamp, and the necessary pressure is supplied by a tank placed at the proper elevation. Inside each lamp-post a small cylinder is fixed, to the piston of which a rod, A, is attached. The top of this rod is formed as a rack, gearing into a wheel, B, toothed for about three-fourths of its circumference, and attached to the lamp-cock, C, which is turned round, opening and closing the cock as the rod rises and falls. A swivel plate, F, forming a half disc, is secured to the plug, and turns with it. Over this is a case, E, containing a week's supply of matches or fusees; these drop, one at a time as required, into a recess in the plate, and in being carried round therewith are rubbed against the roughened surface of a spring, G, and thus ignited light the gas and drop to the bottom of the lantern. To extinguish the light, the water pressure is taken off, by opening an escape tap, when the piston fall by its own gravity, bringing down the rod, and closing the lamp-cock

Another instrument, patented about the same time by Messrs. Stephenson, Bartholomew, and King, was operated by pneumatic power in a similar manner, but failed, principally in consequence of the taps becoming stiff, so that the power applied was insufficient to move them.

The pneumatic lamplighter next illustrated in fig. 47 is the invention of Mr. Foulis. This represents the apparatus two-thirds of the actual size, which, as will be seen, is less in bulk than most lamp regulators, for which it also acts as a substitute.

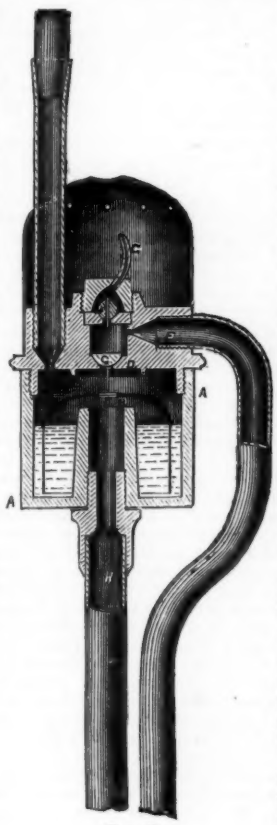

FIG. 47.

It consists of a cylindrical vessel, A, filled to about half its depth with glycerine. In this vessel there is a bell, B, dipping into the glycerine. Attached to the top, by means of a wire, is the valve, C, resting on its seat, D. The gas enters by the pipe, E, above the valve-seat, D. There is a smaller valve, F, immediately above the valve, C, communicating with the jet, G. This valve has an opening through it just sufficient to keep the jet lighted with a very small flame. Through the bottom of the vessel, A, a tube is passed, which rises into the interior of the bell, B. This tube communicates with a small air-holder placed in a lamp-post or other convenient position, on which the pressure may be increased or diminished at pleasure, and the holder may control any number of lamps.

It will be seen that pressure put on this holder will be communicated to the interior of the bell, B, which will rise, and thereby open the valve, C, until the pressure on the top of the bell, and consequently the pressure of gas passing to the burner, is equal to the air pressure in the interior of the bell, less the pressure due to the weight of the latter.

The pressure of the lamps in a district or town may thus be controlled from one central point, independently of the pressure in the mains, or irregularity of levels, in the district.

The action of the instrument as a lamplighter is as follows:—The small jet, G, is kept lighted by the gas passing through the orifice in the valve, F. In order to light the lamps, a pressure slightly greater than the gas pressure in the main is put on the interior of the bell, B, by means of the air-holder. The bell will then rise and allow the gas to pass to the burner; and it will continue to rise until the valve, C, touches the small valve, F, and, opening it, allows a larger quantity of gas to pass to the jet, G, which lengthens out until it comes in contact with the gas issuing from the main burner, and ignites it. The air pressure is then reduced to what is required for the large burner; the bell, B, and valve, C, fall slightly, which allows the valve, F, to drop into its seat, thereby reducing the small jet to its normal size; at the same time regulating the flow of gas to the main burner. In order to put out the light, the pressure is reduced in the air-pipe, and the valve, C, closes. The small jet, G, is protected by a wind-guard.

Mr. Foulis has had some of these lighters in use for several months, and they have not once failed in their action.

CAUSES OF GAS EXPLOSIONS.—Public attention has lately been called to some very serious accidents resulting from escapes of gas. It is well known that one fruitful source of gas escape is the water-joint pendant. This old apparatus, as a gas manager very properly says, is ill-understood by the bulk of gas consumers, who seem to forget that water will evaporate, and very quickly too, in a heated room, so allowing the gas to escape in such quantity as to cause a serious explosion in a very short time. The evaporation of the water in the pendant, and the risk of accident arising therefrom, may be prevented by adopting the following simple and effectual remedy:—Fill with water the water-cup at the top of the outer tube of the pendant to within an inch or two of the top; fill up the remainder with rape or sweet oil, and the pendant will then be safe, and require no attention in this respect for a lifetime. Pendants, if drawn down during the evening, should always be pushed up again before retiring for the night. Another sufferer believes that many of the accidents result from the continued use of pewter pipe, or "tripe," which is very cheap, compared with proper tin pipe, or proper iron tube, and which should on no account be used. This cheap pipe on being bent readily cracks, as it has not the tenacity of good tin pipe, and it can be pierced by a tin-tack. It melts at the low temperature of solder, and if there is a fire it opens at once a way for the gas to burn. The gas-fitters, to do their work quickly, join by a soldered joint any required branches, instead of putting in brass connecting pieces as T's and unions, and cracks frequently occur at these cheaply-made connections.—*Sanitary Record.*

Correspondence.

[We do not hold ourselves responsible for the opinions expressed by Correspondents.]

THE EFFECT OF NITROGEN ON THE TEMPERATURE OF COMBUSTION.

SIR,—I was much surprised at a statement made by Sir Francis Knowles, at the meeting of the Society of Arts reported in your issue of April 30. It is stated by him that "if to boiling water was added an equal quantity of cold water, there would be obtained a heat much below the mean of the two temperatures," and he argues that, therefore, "the mixture of nitrogen with an inflammable gas must much deteriorate the value of the gas as fuel."

This statement is erroneous both in fact and in reasoning.

As a matter of fact, the temperature of a mixture of equal quantities of boiling and cold water *is*, practically, *the mean* of the two temperatures of the waters before mixing. I say *practically*, for there is a minute difference, arising from the fact that the specific heat of boiling water is about one-half per cent. higher than that of cold water. The result of this difference would be to make the heat of the mixture to a very small extent higher, instead of being lower than the mean.

Next, even if the statement of Sir F. Knowles were true with regard to liquids, it by no means follows that it would be true with regard to gases. Indeed, the laws of the specific heats of the former differ widely from those affecting the latter. All the simple gases and carbonic oxide have, *for equal volumes*, very nearly the same specific heat, and most of the other gases differ but slightly from this measure. Their specific heats are, therefore, inversely as their specific gravities. On the other hand, the capacity for heat of liquids varies very widely. For example, 1 lb. of water holds 30 times as much heat as 1 lb. of mercury at the same temperature. The capacity for heat of equal *volumes* (sometimes called the relative heat) is the product of the specific heat by specific gravity; and as mercury is 13·6 times heavier than water, its relative heat, 13·6 × ·033, is only 0·4488 that of water. Again, the specific heat of ether is only ·53, which, multiplied by its specific gravity, 0·715, gives its relative heat, 0·379, or little over one-third that of water. These examples show how erroneous any deductions must be which are based on the presumption that gases follow the same laws as liquids.

When we speak of the value of a fuel, we generally mean the *quantity* of heat developed by its combustion, and not the degree of temperature to which the products are raised; and in the case referred to by Sir F. Knowles, the *quantity* of heat, notwithstanding the mixture with nitrogen, is precisely the same as if no nitrogen had been present; for if there be a lower degree of temperature, there is a larger mass heated. If a glass of whisky be put in a tumbler, there will be the same quantity of alcohol for the consumer, whether he drinks it neat or dilutes it down to "sixteen-water grog." The effects on the palate will be different, but the quantity of spirit taken into the system will be the same. In the same way, the nitrogen lowers the degree, but does not diminish the quantity, of heat. In the burning of anthracite coal, it is usual to admit a jet of steam below the bars of boiler furnaces, in order to dilute and extend the heat through the flues, otherwise the fire-box might be burned, while the ends of the flues would be cold. Of course, for certain purposes a very high *degree* of heat is necessary—for instance, in gas-making and many metallurgical operations; but, for most purposes, the temperature resulting from the combustion of the gas produced by Mr. Kidd's process would be amply sufficient.

About the process itself, its originality or economy, I do not know enough to form an opinion; but, so far as I can understand the apparatus without having seen any drawings, I believe that the mode of supplying steam and air can be greatly improved, and the supply of each more effectually regulated. I think, also, that it will be hard to improve much on Mr. Siemens's principle. If the fuel be completely burned, and all the heat usefully taken from the products of combustion before they escape, nothing more can be done. The only loss I can see in Siemens's gas producers is the cooling of the gas between the producer and the furnace—a cooling rendered necessary to induce the draught employed in that system, and perhaps a slight modification of the apparatus might enable us to dispense with this cooling process.

In making these remarks, I have no desire to depreciate, neither have I any wish to extol, Mr. Kidd's invention. My sole object is to remove a misapprehension which may mislead others. Indeed, I have more than once been surprised at the mistakes which practical men have made from confusing the degree of temperature with the quantity of heat, and as it is a matter of the greatest importance to gas engineers, I trust they will pardon me for calling attention to the subject.

Cork, May 2, 1878. DENNY LANE.

THE REMOVAL OF SULPHUR COMPOUNDS.

SIR,—You noticed in your last JOURNAL (April 30th) a promised new solution of the sulphur difficulty, by introducing into the hydraulic main a stream of ammonia. You may, perhaps, be pleased to learn that the idea is not new to us, but that we know the value of introducing to the hot gas in the hydraulic main a stream of strong purified ammonia, either in the vapour form or solution. In the year 1875 we began experimenting in this direction, and sent our first stream of ammonia into the hydraulic main, the results proving so satisfactory, both with regard to illuminating power, purification, and the absence of naphthaline, that we have continued the process to the present time. Our plan is very simple, and, after using the ammonia as often as we wish, to absorb from the gas the impurities it contains, we ultimately recover the whole of the ammonia in the form of sulphate of ammonia.

Lewes, May 3, 1878. JOHN HAMMOND.

WANTED, A RULE.

SIR,—In your issue of the 9th of April your correspondent, "Q," asks for a rule for determining the yield of gas from ordinary coal, when a certain candle power is required.

The following simple rule will solve all such cases: Multiply the yield of gas per ton by the candle power of the same, and the product will give the yield in *candle feet* per ton. Divide the candle feet by the candle power required, and the quotient will give the yield per ton in cubic feet.

Example: If one ton of coal will produce 9500 cubic feet of 14-candle gas, what will the same coal yield when a 12, 13, 14, 15, or 16 candle gas is required?

Hence $9{,}500 \times 14 = 133{,}000$ candle feet per ton.

For 12-candle gas $\frac{133{,}000}{12} = 11{,}083$ cubic feet of gas per ton.

13 " $\frac{133{,}000}{13} = 10{,}230$ " "

14 " $\frac{133{,}000}{14} = 9{,}500$ " "

15 " $\frac{133{,}000}{15} = 8{,}866$ " "

16 " $\frac{133{,}000}{16} = 8{,}312$ " "

If he would prefer to make his calculations by the pound of coal, he must proceed as follows:—

$\frac{9500}{2240} = 4{\cdot}24$ cubic feet per pound.

Hence $4{\cdot}24 \times 14 = 59{\cdot}36$ candle feet per pound.

For 12-candle gas $\frac{59{\cdot}36}{12} = 4{\cdot}94$ cubic feet per pound.

13 " $\frac{59{\cdot}36}{13} = 4{\cdot}56$ " "

14 " $\frac{59{\cdot}36}{14} = 4{\cdot}24$ " "

15 " $\frac{59{\cdot}36}{15} = 3{\cdot}95$ " "

16 " $\frac{59{\cdot}36}{16} = 3{\cdot}71$ " "

As we cannot get a 25-candle gas from Newcastle coal when made by the ordinary process, we must not apply this rule to extreme cases. Nevertheless, we can make a 25-candle gas from that coal, by using a more complicated process than that now used, if required.

Your correspondent may find more particulars relating to this subject by referring to Vol. XXVIII., p. 93, of your JOURNAL. WM. FARMER.

New York, April 20, 1878.

HOW NOT TO DO IT.

SIR,—I wish to make known to your readers a difficulty which occurred in my experience as to a supply of gas, and I should much like to know how redress could be obtained in such a case. It was this: A small house situated 80 yards from the main wanted a supply of gas—seven or eight lights, perhaps—and, on applying to the Gas Company, the Manager refused to lay down a service-pipe, on the ground of expense, although the house referred to was the first of a row of five or six houses, all of which would no doubt have taken gas. I offered to pay half the cost of the service, which was declined. I then offered to pay for the pipes for the whole 80 yards, which was again refused, I believe, on the ground that there was no place to fix a meter at the commencement of the service-pipe next the main. After this I ceased to wonder what had made this Company the most unpopular Company in the district. I should mention that the price charged for gas is 5s. per 1000.

ENGINEER.

SIR,—I am one of those "Country Gas Managers" who have recently been called upon to supply gas to premises, not 25, but 300 yards from our nearest main. I do not now write to you so much to complain of that, as to offer a few remarks upon Mr. Livesey's letter in your JOURNAL of this week.

In reference to the operation of the 11th clause of the Act of 1871, I should like to ask whether, in the event of the forecourt, garden, or open space, being just within the 75 feet, the Company could not insist upon the meter being placed at that point, and not, perhaps, at 300 yards further distance, or even more, up a coach-road, or through gardens leading up to a residence, where, as is often the case, only the servants apartments and passages are to be supplied with gas?

I conceive that this will make all the difference. "Country Managers" are not always, or even often, alarmed at the expense of 30 feet of service-pipe—which, by the by, will cost more than Mr. Livesey states, if of proper capacity; and the greater the distance, the greater the need of ample diameter of service-pipe—but, at the probable prospective loss through leakage, &c., which is sure to arise at some time; or whence the "Unaccounted-for" gas which we all have to chronicle? To be plain, I will illustrate what I mean. Suppose a gentleman, having a villa residence, or "hunting box," approached by a carriage road a mile long—and there are many of them—and the entrance gate of the carriage road is within 75 feet of the Company's main, I take it that such owner or occupier is entitled, under Clause 11 of the 1871 Act, to call upon the Company to supply his house with gas, even though only for the domestic apartments and passages, and yielding a revenue of, say, £15 a year, he agreeing to pay all cost beyond the entrance gate. I do not think his title can be disputed; but, surely, the Legislature never contemplated that the Company should be required to lay for such a purpose—even at the cost of the applicant—a mile of pipe before the meter was fixed. I cannot help thinking that the Company might insist upon fixing the meter at the point where their gratuitous duties cease—viz., 25 yards from their main.

I should like Mr. Livesey to clear up this point.

In my own case, right or wrong, I am insisting upon it, notwithstanding it is a Government application, and the property is contiguous to our main. For their convenience they wished the meter placed at a specified point—300 yards from the main—and they will even bear the whole of the expense; but I reply, "For our security you must place it

at a point 25 yards from our main," and, not to be mean, we offer to lay beyond the meter a further 25 yards of 3-inch main gratuitously.

There are several towns I know in which small villas, rented at from £20 to £80 a year, are being built in their own grounds, and the Companies, small and poor, would feel the cost to be serious, even if only £1 or £2, to carry services to these villas, which, possibly, may only be used a few weeks in the year, in the summer season, so that it is utterly impossible the consumption would repay the outlay.

Undoubtedly, for every additional 10,000 feet of gas sold, we have to carbonize more coal, pay more wages, and, sooner or later, put up more retorts and gasholders; or does Mr. Livesey imagine that all increase of gas-rental is so much net profit?

If such were not so, why the perpetual extension of gas-works throughout the whole country? If many half-yearly accounts show an increased rental and a diminished expenditure for coal, that may arise—as Mr. Livesey knows—from several causes, perhaps from improved manufacturing and distributing plant—it may be fromlower coal contracts; but suppose you are up to the mark in these matters, then surely increased demand means increased supply, and that means—soon enough in some cases, and ultimately in all—increased charges on every head of expenditure, capital account included.

I think the experience of every Metropolitan and Country Manager will bear me out in this matter.

My remarks on Mr. Livesey's letter are in no way unfriendly, for, knowing him as I do, I yield to no man in my high regard for him, and my estimation of the many and good services he has rendered by his readiness to supply any information or explanation likely to be of use to Gas Managers.

THOMAS STONE.

Weymouth, May 2, 1878.

Parliamentary Intelligence.

HOUSE OF COMMONS COMMITTEE.

WEDNESDAY, MARCH 13.

(*Before the Marquis of* LORNE, *Chairman; Mr.* STARKEY, *and Mr.* ERNEST NOEL; *Sir* JOHN DUCKWORTH, *Referee.*)

CHELTENHAM WATER BILL.
CHELTENHAM CORPORATION WATER BILL.

(*Continued from p.* 677.)

Dr. *Wilson* was recalled and cross-examined. He said: I have frequently got rid of diarrhœa in a house by simply directing my patients to change their water. They were in the habit of using well water, and I told them to use the Company's water. I certainly do not approve of supplying Cheltenham from the sand. It is my opinion that a navigable river should not be chosen as the source of water supply for drinking purposes, when any other source is available. I cannot say that this opinion is founded upon any particular statistics, but it is the result of my reading and observation. There are several populous towns in the basin of the Severn above Worcester; but I have not studied the health statistics of Worcester. I do not know that Wolverhampton, Walsall, Dudley, and other towns drain into the Teme, or that before 1854 the sole supply of water for Birmingham was obtained from that river. I do not know that cholera was extremely violent in the Black Country in 1854, and that not a single case of cholera originated in Birmingham. Without knowing all the factors in the case, I cannot give any explanation of the figures in the Registrar-General's report, which show that while in 1849 the deaths from cholera in Wolverhampton were 1865, the deaths in Birmingham, lower down the river, were only 29. I am not aware that cholera always ascends a river instead of descending, though I know it sometimes does.

Dr. *Wright*, Medical Officer of Health for Cheltenham, said: I have resided in Cheltenham since 1842, and for many years was senior surgeon of the hospital. I have a considerable stake as a Shareholder in the Water Company. The poorer parts of the town depend almost entirely on wells, and that supply is very unsatisfactory; but the Company cannot be blamed for this, as they have no mains there. There have been applications to the Company to supply the poorer parts. There have been cases of fever arising from the want of a proper water supply to the poorer cottages. Upwards of 3000 houses are rated under £10 per annum in the district; 368 of these are supplied by the Company. There was no main in the North Ward until about last April. Since the Corporation have taken action, the Company have been very active in laying down mains in the town. Some time ago a conference took place between the Company and the Public Health Committee of the Town Council. I was asked to point out which district most required additional mains, and I indicated the Sherborne Street district, because I had had my attention called to several cases there of typhoid fever arising from the water, and because it would have been possible to supply that district with a constant service without interfering with the intermittent system of the town. I have no hesitation in saying that no Sanitary Authority can possibly carry out the Public Health Act who do not hold command of the water supply in their own hands. Besides the ordinary sewage, there is a considerable number of dead bodies of animals floating about on the surface of the Severn. The ova of the entozoa from the dead cats and dogs are therefore likely to get into the human system if the water is drunk. I certainly do not think that the Severn water ought to be sanctioned for a place like Cheltenham. The feeling upon this subject in the town in 1865 was something remarkable. The aristocracy of the town are unanimously opposed to the introduction of Severn water. Apart from the sanitary point of view, the very thought of drinking the contents of an impure river is repugnant to their feelings. However unreasonable that aversion might be, if it drove people away it would be injurious to the prosperity of the place. Everything has been done, on the part of the Water Committee of the Town Council, that could be done to come to terms with the Company. I consider that the conduct of the Directors has been most arbitrary. All the Shareholders who have spoken to me on the subject would be very glad indeed to treat with the Corporation on the basis of their offer; but the thing has been stopped *in limine* by the Directors and Officials of the Company.

Cross-examined by Sir E. BECKETT: The result of the voting by proxies at the Wharncliffe meeting was that there was a large majority in favour of going on with the Bill. The question as to purchase by the Corporation was not put to the meeting. The Corporation have not done anything since last year towards enforcing the supply of water in the Sherborne Street district. There have been no complaints recently from that district, and therefore there has been no special reason for bringing compulsory powers to bear. The great objection is to the cost of cisterns, &c. It is an exceedingly difficult thing to work the compulsory powers of the Public Health Act. I do not think the Corporation could call upon owners of small cottages to erect cisterns, ball-cocks, &c., which would cost £5 at least. I told the Company that it was no use putting down mains unless there was to be a constant supply. They said they could not give it. I have not entered into the question whether there are any towns in which the objects of the Public Health Act have been attained, although the Corporation have not the control of the water supply.

Sir E. BECKETT: What do you imagine you can do, supposing you get your Bill, that you cannot do with ours?

Witness: I think, upon the report of the Surveyor, we should, without any hesitation, carry our mains to any district, if the works were in our hands, and we cannot do that now—or, at all events, we do not do it.

Cross-examination continued: I do not think the Company thought of coming to Parliament until they knew that the Corporation were going to take action, and Mr. Hawksley told them it would be useless for them to oppose the Corporation Bill unless they had one of their own.

Dr. *Alfred Hill* said: I am Medical Officer of Health and Borough Analyst to the Corporation of Birmingham. I constantly trace a connection between the prevalence of typhoid fever, diarrhœa, and other diseases of that class, and the use of sewage water. In 1849 and 1854, when certain parts of London were supplied with Thames water, cholera was evidently produced by the use of it. In the former year, when the Southwark and Lambeth Companies drew their water from below Battersea Bridge, within the tidal influence, and therefore within the influence of pollution from sewers, the districts supplied by them suffered very much from cholera, and suffered equally. Subsequently, in 1854, when the Lambeth Company had removed their intake to above Teddington, it was found that there was a very high mortality from cholera in the district supplied by the Southwark Company, and a very low mortality in the district supplied by the Lambeth Company. In 1866, when one of the reservoirs of the East London Company was accidentally contaminated by polluted water from the Lea, it was satisfactorily made out that the cholera which existed that year was coincident with the supply of water from that source. Another illustration of the effect of sewage in water was afforded by the town of Doncaster. According to Dr. Simon's report, the epidemic of cholera in Sheffield began a few weeks before that in Doncaster, which is lower down the river, and terminated a fortnight before. That shows that infected sewage was not purified by passing 15 or 20 miles down a river. The facts are against Mr. Hawksley's statement that sewage is annihilated by a flow of 15 or 16 miles. Those who hold that view mistake clarification for purification. What may be called natural sewage I think may frequently be drunk with impunity. It is specially-infected sewage that is dangerous. A chemist cannot by analysis point out the specifically infected substances. He can only give the chemical character of the water, from which he may draw an inference as to its being polluted or not, but he cannot say that it is positively injurious to health. That can only be proved by a physiological test—namely, by the disease being produced in those who drink it—and that is an experiment which all wish to avoid. It has been tried over and over again, with very fatal results. I think it is indispensable that all local authorities should have the control of the water supply. I assisted the Town Council of Birmingham two years ago in getting the control of the water-works and we have reason to be highly satisfied with the result. We find that we can carry out reforms which it was impossible for us to carry out when the supply was in the hands of the Company. The health of our town has been improving for some years, in proportion as attention has been paid to general sanitary regulations, including the water supply. Birmingham used to draw a large supply from the river, but the inhabitants are gradually relying more and more upon those streams which are fairly pure, and upon the water from the deep red sandstone. I do not know of any previous case of a Company who had obtained their parliamentary powers on the faith of giving a spring water supply, afterwards coming to Parliament to substitute a river water supply. I know a great many cases of the opposite process. The common-sense feeling is that those rivers which are sewers for the country should not be used as sources of water supply. I do not think it is in any sense justifiable that this Company should endeavour to use their position to force upon a community an inferior supply to that which they were first authorized to give. The sanitary obligations of a public authority cannot be properly carried out unless they have the control of the water supply.

Cross-examined by Mr. VENABLES: I believe when the Committee of the House of Lords passed the Birmingham Water Bill, the Chairman expressly stated they passed it on the ground that under a former Act, which was passed with the consent of the Company, the Corporation had power to purchase. I know that Dr. Letheby said there was no proof of choleraic pollution of the water at the East-end of London, but I read both sides of the story, and I do not agree in his view. Probably the intake of the Southwark Company was close to the discharge of a large sewer. According to modern physiological views, fœcal matter does not get oxidized by passing down a river. As the water supply of Birmingham has increased, disease has diminished. The diseases which are likely to be communicated by impure water are cholera, diarrhœa, and typhoid; it would not extend to scarlet fever.

Dr. *Frankland*, F.R.S., President of the Institute of Chemistry, Professor at the School of Mines, and one of the Rivers Pollution Commissioners, said that he had in 1865 visited the Severn with Dr. Odling, with the view of assisting the inquiry in that year. He was well acquainted with the basin of the Severn from its source to the tidal estuary. In the winter season the Severn was liable to heavy floods. It must be regarded as a peculiar river. It differed widely from the Thames, since there were in the latter no highly absorbent strata. The flow of the Thames was much more equable than that of the Severn. In times of flood, scourings from the surface of the land were brought down by the Severn. There was, however, a remarkable difference between the Severn and the Thames. In the Thames basin the flood water was always the worst, whereas in the Severn basin it appeared to be generally the best. When the River Severn was low, it was a very bad quality, whereas it was a fact that the water of the Thames above Teddington Lock was at its best. He did not think that the Severn water was a proper water to be supplied to any town, and it would be little short of madness to supply it to a town like Cheltenham, the prosperity of which depended mainly on its sanitary condition.

Mr. POPE: You think that the reputation of a place like Cheltenham should be beyond reproach?

Witness: I do.

Mr. POPE: Do you believe that in a run of 14 miles the sewage of a town like Worcester would be destroyed by oxidation?

Witness said he did not. He had made experiments on the Thames, Irwell, and other rivers, and he had come to the conclusion that oxidation was a question of degree. In a flow of 15 or 20 miles, he was of opinion that oxidation was very slight indeed. There was no river in the United Kingdom long enough to oxidize sewage, even although it was put in at the source of the river. On the Severn there were manufactories and mines, and at times he had ascertained that there was an appreciable amount of contamination arising from such circumstances. He had found arsenic in the Severn above the town of Newtown, in Montgomeryshire. In the summer time the flow of the Severn at Tewkesbury was as low as 90 million gallons. The minimum flow of the Thames at Teddington, within the last 15 years had been 350 million gallons daily, but that was after the abstraction of the water for London. There were impurities that

found their way into rivers which defied chemical analysis. A chemist might find impurities, but he could not distinguish between the healthy organic matter of sewage and the organic matter containing bacteria and the various germs of disease. Cholera poison might be in water, and yet it might not be detected by analysis. During the last visitation of cholera in London, in 1866, he obtained the evacuations of a patient who had died of cholera, and from the experiments he had made, after mixing it with water, he was unable to detect the impurity.

Mr. POPE: Have you any belief in the existence of germs of disease, such as we have heard described?

Witness: There can be no doubt about it. It is a matter of common knowledge among scientific men.

Examination continued: If Cheltenham was supplied with water from the Severn, it was obvious that the Sanitary Authority would have no control over the pumping of water or the supply. He did not think it was possible, by any practical means, so to purify the sewage as to guarantee its freedom from disease germs. The water from the Cotswolds was excellent. It was the same class of water that supplied the Thames basin, and was derived from the oolitic formation. He produced several samples of Cotswold water, and explained its properties, and expressed his opinion that it was admirably adapted for the supply of a town like Cheltenham, if it could be obtained in sufficient quantity.

Cross-examined by Sir E. BECKETT: The reason was because it was derived from sources which had no sewage contamination, and because it was palatable, bright, and sparkling. No doubt the water that fell as rain would be, to a certain extent, surface drainage. As investigation went on, it seemed to draw the line of suspicion tighter and tighter around water as the source of disease. Many thousands of people had had cholera or typhoid fever through drinking water. The evidence afforded by the two epidemics of 1849 and 1854 was most conclusive on that point. Nothing could be more conclusive, unless the poison was administered to people, and the effects were noted. He did not think distance made any difference in the injurious effect of sewage. While London was drinking its own sewage, there was a great deal of cholera. In the year 1866, when all London was drinking either Thames water or Lea water, there was an outbreak of cholera; but whether it was in consequence of drinking that water he could not say. Since the Thames water had been taken from above Teddington Lock, people who drank it had died of cholera. The cholera in the East-end of London was said to have arisen from the leakage of some Lea water, which had received sewage, into a reservoir. The drain in that case was not far from the reservoir.

By Mr. NOEL: I made an analysis of a sample from the pure-water tank at Tewkesbury. In the analysis furnished by the Company, the organic carbon was ·155, and the organic nitrogen ·036. My own analysis showed that, in the sample supplied to me, there was ·244 of organic carbon and ·032 of organic nitrogen, so that the proportion of sewage matter was slightly less than in the Company's analysis.

THURSDAY, MARCH 14.

Mr. *J. E. Way*, examined by Mr. BALFOUR-BROWNE.

I am a consulting and analytical chemist, and was for many years consulting chemist to the Royal Agricultural Society of England. I was a member of the first Rivers Pollution Commission. In 1864 I examined samples of Severn water, and gave evidence before the Commons Committee on the Bill of 1865. I considered that the Severn water was not a proper water for the supply of Cheltenham. I was in favour of a supply from the springs in the neighbourhood, that water being of excellent quality. I considered the Severn water was unfit, from the fact that the river receives the drainage and sewage of a large district. It was a sluggish, muddy river. Its temperature varied greatly with the seasons of the year; but the spring water has an equable low temperature. As Cheltenham is the resort of invalids, it is peculiarly dependent upon its water supply. I visited the springs in the neighbourhood on the 23rd of February. I saw the Dowdeswell Wood Spring. I should hardly like to say the probable quantity of water, but the whole hillside seemed to be full of water; in fact, it was most unpleasant to walk on. The ground seemed very favourable to the construction of reservoirs. I have examined samples of water from the Dowdeswell, the Lynover, and the Rosley Wood Springs. They are very good, pure, and bright, and of good colour and taste. The water on evaporation gives an absolutely white residue, whereas the water of the Tewkesbury supply, and still more that of the Severn, unfiltered, gives a brownish yellow residue. There is nothing more distinctive of the purity of water than that very simple experiment. All river waters give more or less tinge to the residue.

Mr. BROWNE: Does the analysis show the spring waters are free from an excess of saline and organic matters?

Witness: Yes; they contain a very moderate proportion of organic ammonia. They are considerably softer than Thames water, and become very soft after boiling.

Is it your opinion as a chemist, from your examination of these waters, that they may be safely recommended as a good town supply?—I have not a doubt about it. The impurity of the Severn water, as indicated by the organic ammonia, is considerably in excess of the spring water. In the case of the Tewkesbury supply, it is fully twice as much as in any of the springs.

Do you adhere generally to the opinion you gave in 1865, that Cheltenham should be supplied from springs, and not from the river Severn?—I think, unless there is an absolute necessity for going to the Severn, that the water supply should not be taken from it.

Is it conformable with your experience that a considerable amount of sewage might be present in such a river as the Severn without being detected by chemical analysis?—If you take absolutely pure water, you will necessarily find no organic nitrogen, and on no account ammonia; but according to the relation in which the water becomes impure by drainage and sewage, so the organic nitrogen becomes considerable. The whole question is a question of degree. No chemist would attempt to say exactly when a water was an injurious water; but if there is an increasing amount of impurity, the water might very properly be considered to be liable to danger, if not actually injurious. Whether considered in the form in which I make my analysis, which is of organic ammonia, or taking it in the form in which Dr. Frankland, Dr. Tidy, and other chemists make it, which is of absolute organic nitrogen, the properties indicating sewage or matter of that kind are, in the hundred thousand parts of a gallon, extremely small. In such an analysis, as Dr. Frankland put in, the quantity that is represented by even the third decimal figure in the analysis actually represents thousands and tens of thousands, I was going to say hundreds of thousands of gallons of sewage, present in the water. Supposing the river has now a supply of absolutely pure water—I do not say that it has—but supposing it has, the figures that have been given by the chemists, for the quantity of organic nitrogen, would represent from 400,000 to 500,000 gallons of sewage by the time it got to Tewkesbury. I have no doubt, as all chemists are aware, that an apparently very small quantity of organic nitrogen may indicate a large quantity of sewage.

The figures in the analysis convince you that Severn water is not good for household or drinking purposes?—The figures are consistent with impure water.

Cross-examined by Mr. MICHAEL: I do not think my recent investigations induce me to alter my opinion as to the meaning of the analysis of water or the modes of conducting it. There are two methods of analysis, one by Dr. Frankland, which is adopted by a good many chemists, and the other by Professor Wanklyn. They are both good; the difference being probably that Dr. Frankland's, so far as nitrogen is concerned, gives the absolute quantity of nitrogen, and Dr. Wanklyn's gives the relative quantity of nitrogen; that is to say, two waters will give different quantities of nitrogen in the form of ammonia, which do not indicate any absolute quantity, but undoubtedly indicate a relative quantity.

Mr. MICHAEL: Are chemists agreed, when you have got your absolute quantity of nitrogen, what it means?

Witness: They may in course of time be able to say whether so much absolute nitrogen is injurious, but they can only say so now in a broad way.

Are you able to say what the absolute amount of carbon is?—If there was nothing but nitrogenous matter passing into the river, the carbon and the nitrogen would correspond; but there are vegetable matters and peaty matters, and so on, that cause a difference in the carbon.

Has anything else occurred which has changed the views you held for some time with respect to water and sewage contamination? What is your general idea of an analysis?—Analysis undoubtedly tells you what is the state of the water with regard to organic matter; but when you have got that analysis you have still to say where the point of danger commences.

Can you say that?—Not absolutely, but relatively. We can say, "Here is a water free from organic matter, and here is one that shows a great deal." We say the latter is more likely to prove injurious, not that it is absolutely injurious, but that it is more possible it would be injurious than the water that contains little organic matter. I do not know what is the quantity of organic nitrogen that should exist in order that the water might be ranked as a dangerous water for ordinary domestic purposes. That is a point on which Dr. Frankland has given his opinion; but I should not like to say.

Do you think that any sewage could be in water without detecting it?—We detect it by inference, by the quantity of the organic nitrogen or organic ammonia. Sewage in running water is no doubt oxidized to a considerable extent. I should say oxidation commences immediately it is put in.

What is the important element of oxidation in a river? Is it time or distance?—They are much the same thing. The more the water is aërated the more rapidly would the sewage be got rid of

Do you take it that it is owing to the presence of air alone without reference to vegetation?—Yes.

How long do you think sewage would be in the water before the process commenced?—It is impossible to say. I believe the moment the sewage enters the water oxidation begins.

How many miles would there be in an ordinary river before oxidation begins?—That is impossible to say. I do not think I have ever said how many. I cannot give you any idea. I have not had an opportunity of making any analysis of the river to determine what the quantity of organic nitrogen is at various points. That would be a test of the comparative purification. My point is this, that the differences are so small, to indicate the getting rid of a very fair quantity of sewage, that the errors of analysis would be more than those differences.

If there are two modes of analysis, and both are correct, there must be a relation between the two?—They are not absolutely comparable; they are comparable in their results, but not in figures. From analysis I find that there is twice as much organic ammonia given by the Tewkesbury supply as there is by the least pure at the spring, and eight times as much as by the most pure at the spring.

I suppose I may take it that water, especially coming over a manured surface, can hardly have so small a proportion of organic nitrogen as this water you have taken out of the springs?—The water coming from Dowdeswell Wood would principally take up the matter of dead leaves. It is an extensive wood, covering all the hillside. There is no chance of manuring the wood, and if there is any impurity in the water, it will be of the vegetable character. I do not say that the colour of the ash, after the water is analyzed, would give any information as between vegetable and animal matter. The Severn water I examined, after filtration, was not coloured with peat.

If I had sent you, without any information whatever, a sample of this water, and told you nothing of the source from whence it was derived, and you had made an analysis according to Professor Wanklyn's method, would you have said it was a dangerous water?—No; I should not have said that; and in one case out of a hundred, it is not a dangerous water. If it be overloaded with organic ammonia, you might fairly say it is a dangerous water; but nobody pretends to say that that quantity of organic ammonia makes the water dangerous. There is a difference between water being dangerous, and being liable to be dangerous. So far as my analysis is concerned, the water is very similar to the water of the Thames, and I do not consider Thames water as dangerous, although it is not so pure as it ought to be.

Mr. BROWNE (in re-examination): When you have a choice of water which is very pure, and a water which is not so pure as it ought to be, if you had been asked to recommend one of these, you would have recommended the spring water?

Witness: Undoubtedly, I should have done so.

Dr. *Stodhart* said he was a Fellow of the Chemical Society, Fellow of the Geological Society, and Analyst to the City of Bristol and to the County of Somerset. He had made an analysis of the water obtained from the springs at the head of the Dowdeswell Valley. The springs flowed from the upper surface of the lias clays. They did not flow through the lias, but simply over it, the lias being impermeable. They made their exit at an altitude of about 700 feet above the level of the sea. He found the spring water to be free from any trace of sewage or contamination. Before he got the water at the springs, it must have passed through a thickness of 160 feet of oolitic beds, and he should have expected more solids than he actually found. There was very little solid and very little hardness. There was a minute quantity of organic matter in solution; but he thought that resulted from vegetable origin. He thought the water would be suitable for such a place as Cheltenham, and agreed with the other witnesses that it contained a very small quantity of nitrates. He also made an analysis of the water taken from the stream at the side of the reservoir, and found it of very good character, and fit for a town supply. He thought the place chosen for the reservoir was uncommonly well suited for the purpose. He had made hundreds of analyses of the water of the Severn in the course of his life, but the analyses he made within the last few months showed considerable differences in the quality of the water from time to time. The principal difference between the Severn water and that of the springs would be in the quantity of ammonia, but if the dilution of the water was taken into consideration, the organic ammonia must be very large indeed. He was totally surprised when he heard that anybody in Cheltenham ever dreamed of having a supply from the Severn.

Mr. *Taunton*, C.E., said he was formerly Assistant Engineer to the

Grand Junction Water-Works Company, and had constructed water-works at various places. He had also been Engineer to the Thames and Severn Canal Navigation Company for nearly 26 years. So early as 1854 his attention was directed to the Cheltenham Water-Works Company. He was concerned with the late Mr. Simpson in opposing, on behalf of the Proprietors of the Colne Valley, the application to take the Sierford Springs. That Bill was thrown out because the fact was established that there were waters on the west side of the Cotswolds that were available for the supply of Cheltenham. In 1854 he caused gaugings to be taken of the springs and streams in the neighbourhood of Cheltenham. In the dry weather season, in March of that year, the Dowdeswell Wood Spring yielded 1,266,728 gallons per day, and the Leckhamptom Spring yielded 433,368 gallons. Gaugings were also made of the two branches of the Prestbury Brook. The main branch gave 343,872 gallons per day, and the smaller branch 49,428 gallons. Neither the Leckhampton nor the Prestbury Spring flowed into the Chelt. In 1864 he was employed by the Commissioners of Cheltenham to report upon any matters connected with a water supply. He recommended, amongst other sources, a supply from the Chelt as being the best. The scheme was identical with the present one, except as to the site of the reservoirs. The Chelt was the principal stream in the district, and sufficient water being obtainable for the present wants of Cheltenham, he had selected it as the best source. He took the minimum gauging of the stream in March, 1864, and had taken the average flow of water at 1,375,000 gallons per day, but he had since worked out an average of 1,465,000 gallons per day. He thought the results taken in 1864 were to be relied upon, because the gaugings were taken over a considerable period. The rainfall in 1864 was one of the lowest that had ever been known in the Cotswold district. On April 29, 1864, he took a gauge of the Chelt at Dowdeswell mill. There had not been rain for 20 days, and it was then yielding 576,000 gallons per diem. These gaugings were made by direction of the Cheltenham Commissioners, for the purpose of a parliamentary inquiry that was pending about that time. He also gauged the stream on the 19th of July, when there was a general drought, and there was at the Dowdeswell mill a yield of 197,000 gallons per day. That was, however, an exceptional period of drought. In 1865, when the Cheltenham Water-Works Company proposed to take powers, he made other gaugings, but it was not a favourable season The minimum gauge between the 22nd of February and the 13th of March was 1,256,360 gallons per day. That was got at Dowdeswell, just below the osiery. Prestbury Brook gave 439,722 gallons. He had prepared an abstract of the gaugings taken at the three different periods. Starting at the time when there was a moderate fall, the Chelt at Dowdeswell yielded nearly 1,250,000 gallons per day; and after a drought of somewhat over a month he found it yielded between 500,000 and 600,000 gallons per day, and the lowest yield he had ever found, at the driest time he had ever known, was about 200,000 gallons per day. In periods of flood these springs gave out about 7,700,000 gallons per day. The purpose of the reservoir in his scheme, and that now before the Committee, was to store flood water when the rainfall was reduced to its lowest. He had no doubt that the hills around Cheltenham would afford an ample supply for the town; in fact, they could supply more than was necessary. With the storeage proposed, 400,000 gallons per day might be taken as a fair average yield of the streams feeding the Chelt during a time of flood; 600,000 would be provided by storeage, making a total of 1,000,000 gallons per day uniform supply. The cost of the scheme of 1864 he estimated at £30,000. The reservoirs proposed by Mr. Bateman were larger than those of his scheme of 1864, and, therefore, the present estimated cost would be higher. He thought that Mr. Bateman's estimates were safe. He then gave some detailed information as to the rainfall of the district, and said that, in his opinion, the proposed watershed was well suited for the collection and distribution, by gravitation, of water to Cheltenham; in fact, it could not be better. He considered it quite sufficient for all present or prospective requirements. It was an unquestionably better plan than going eleven or twelve miles up the Severn, and pumping water to a height of 370 feet. The permanent expense of pumping and filtration was one of the great objections to the Company's scheme; but the greatest objection was supplying river water to such a town as Cheltenham.

Cross-examined by Sir E. BECKETT: The gaugings he made in 1864 extended over a period of 20 days, in March and April. There were no gaugings taken between the end of April and the middle of July. He took the guagings for the purposes of a parliamentary inquiry. In April the South Cerney Bill fell through, and he took the other gaugings on his own account, as a matter of curiosity, with a view of arriving at the lowest possible flow of the Chelt. The average of the 20 days in spring was 2,250,000, and the minimum flow 200,000 gallons. The drainage area through which the streams passed, available for the supply of Cheltenham, was 6400 acres. He was not proposing to deal with these 6400 acres, or the streams of it, in any way whatever.

Sir E. BECKETT: What is the real area you deal with?

Witness: I am dealing with no area; I am stating that there are 6400 acres of gathering-ground around Cheltenham, which may be made available for the supply of the town.

Mr. *Humphris*, Borough Surveyor, gave evidence as to the number of streets that had none of the Company's mains in them. There were nearly eight miles in all. The greatest portion that was unsupplied was in the North Ward. The streets were generally composed of houses of the poorer class of property. In his capacity of Surveyor, he had had to do with the putting up of urinals, and wells had to be sunk because there were no means of getting water from the Company without cisterns, which it was inconvenient to place there, and also because no terms had been come to for a supply. The Corporation proposed to purchase the mills on the stream, and to do away with the dams, which had the effect in a time of flood of seriously interfering with the drainage, and of flooding some of the houses. He had prepared a table of gaugings taking from September to the end of February—they were taken at the side of the proposed reservoir. Comparative gaugings of the streams of Dowdeswell and Sandford showed that about half the total of the streams above Sandford mill could be taken into the reservoir. In addition to the springs proposed to be taken, there were others which could be included at some future time.

Mr. *John Frederick Bateman*, examined by Mr. BROWNE, said: I have had experience in hydraulic engineering for more than 40 years. In 1854 I was requested by the Improvement Commissioners of Cheltenham to consider the best means of getting water for the supply of the town. They did not complain of the quality of the water given by the old Company, but they considered the quantity quite insufficient. I examined the springs and streams flowing from the Cotswolds. I had examined the whole of the district when considering the water supply for Gloucester, and finally determined that the best place from which to obtain a supply of water was, geologically speaking, identical with the district now proposed for Cheltenham. I recommended the construction of a reservoir on the Chelt, near Dowdeswell, because I believed that a sufficient quantity of water could be obtained from there for the supply of Cheltenham, and at the cheapest rate. I examined the district again in 1864, and came to the same conclusion. Last year my previous opinions were confirmed by further examination, and I recommended the Corporation to prepare the plans which are now before the Committee. The gaugings which were taken, except the few by myself and assistants, were those taken by Mr. Taunton and Mr. Humphris, from time to time, and I was satisfied from these gaugings that not only was there a large supply of spring water from the Cotswolds, in the neighbourhood of Cheltenham, but I felt justified in assuming that the quantity of spring water in the valley of Dowdeswell, where the reservoir was proposed to be placed, would, in a long drought, equal 400,000 gallons per day, and the reservoirs which would collect the flood waters ought to be made large enough to supplement the amount of water during a dry period. The question, therefore, to be decided was the size of the reservoirs; and, assuming 400,000 gallons as the produce of springs, I directed that reservoirs should be laid out, which should contain 150 days supply of 600,000 gallons a day, so as to make up the total quantity of 1,000,000 gallons a day. The gaugings taken in 1864 are more reliable than those of last year. The geological character of the district is very favourable for the production of spring water. Cheltenham contains about 52,000 population, including the suburbs, and it is not very rapidly increasing. It is a residential place and a place of enjoyment, and has no manufactures, so that 20 gallons per head per day would be sufficient. The estimate for the works is £51,500, including the purchase of the mills, and this I think adequate for all purposes. In my opinion the water at Dowdeswell is far superior to that of the Severn at Tewkesbury. I think Corporations holding water-works are calculated to carry out more satisfactorily than Water Companies the sanitary improvements of a town, because Companies look only to their dividends.

Sir E. BECKETT (in cross-examination): Will you explain why, after recommending 250 days supply for Gloucester, you only take 150 here?

Witness: 180 days may be required; but, if you lengthen the duration of the drought, you probably increase the volume of the springs, because, during a very long drought there is a certain amount of rain falling, and, in a geological formation like this, the water permeates the oolite, and the springs are probably increased.

(To be continued.)

Legal Intelligence.

HIGH COURT OF JUSTICE—COMMON PLEAS DIVISION.

FRIDAY, MAY 3.

(Before Lord COLERIDGE *and Justice* DENMAN.*)*

WALKER *v.* THE GASLIGHT AND COKE COMPANY.

The plaintiff in this case claimed damages for very serious injuries suffered through the giving way of a derrick at the defendants works at Bromley, where the plaintiff was employed as a labourer in the service of some contractors who were erecting a coal lift there. At the trial before Justice Manisty, at Chelmsford, the Jury found for the plaintiff, with £1050 damages, and his lordship had declined to give any facility for questioning the verdict.

Mr. WILLIS, Q.C., now moved for a rule for a new trial, contending that there was really no evidence of negligence on the part of the defendants, and that the damages were excessive. He added that he had affidavits that the plaintiff had since the verdict been seen walking about apparently free from distressing symptoms he had exhibited previously.

Lord COLERIDGE said there would be a rule upon the affidavits, so it might as well go upon the other points.

LEEDS POLICE COURT.—FRIDAY, APRIL 26.

(Before Mr. BRUCE.*)*

CONVICTION FOR WASTING WATER.

Mary Ann Whitwam, of 13, Cross Belgrave Street, was summoned, under the 40th section of the Leeds Water-Works Act, 1867, which enacts "That if any person supplied with water by the Corporation shall wrongfully cause or suffer any pipe, valve, cock, cistern, bath, soil-pan, water-closet, or other apparatus or receptable to be out of repair, he shall for every such offence forfeit to the Corporation any sum not exceeding £5." A second summons was also taken out against the defendant, under the 26th section of the Leeds Corporation Water Act, 1874, which enacts "That any officer of the Corporation, duly appointed for the purpose by them, may, between the hours of nine in the forenoon and four in the afternoon, enter any building or place supplied with water by the Corporation, in order to inspect the meters, pipes, fittings, and apparatus for regulating the supply of water, either for the purpose of ascertaining the quantity consumed or supplied, or to see whether the meters, pipes, fittings, cisterns, or other apparatus provided be in good repair; and that if such agent or other officer at any such time be refused admittance into such premises for the purposes aforesaid, or be prevented from making such examination, the occupier shall for every such offence forfeit to the Corporation a sum not exceeding £5."

The defendant did not appear.

The TOWN CLERK (Mr. G. W. Morrison), who appeared in support of the information, said that on Monday the 4th of March, Geo. Wilkinson, an Inspector of Fittings to the Corporation, visited the house of the defendant to examine the water-fittings, and having reason to believe that the ball-cock in defendant's cistern was out of repair, requested to be allowed to go upstairs to examine it, but defendant would not allow him to do so, and forthwith shut the house door in his face. Wilkinson reported this to Mr. Wood, the Chief Inspector of Water-Fittings to the Corporation, who wrote the following letter to defendant:—

Leeds Water-Works Department, Victoria Road, March 5, 1878.

To Mrs. Mary Ann Whitwam, 13, Cross Belgrave Street, Leeds.

Madam,—The Inspector of Water-Fittings called at your house yesterday, when you refused to allow him to make the necessary examination of the water-fittings. As this is not the first time you have done this, it is my duty to inform you that the Act of Parliament provides that the officers of the Water-Works Committee may, between the hours of 9 a.m. and 4 p.m., enter into the houses of persons supplied with water by the Corporation, for the purpose of examining the water-fittings to see that they are kept in good repair, and any persons refusing the officer admittance, render themselves liable to a penalty of £5. We have no desire to cause unnecessary annoyance, and hope, when the Inspector calls again, it will be convenient for you to allow him to make the necessary inspection.

(Signed) GEORGE WOOD, Chief Inspector of Fittings.

On the 11th of March the Inspector called again, and was permitted to enter the house. When he got upstairs, he found the ball-cock in the water-closet cistern was out of repair, and allowing the water to run to waste down the overflow-pipe almost at full bore. He told defendant of this, and said she must get it repaired. She said she should not do it; whatever was required to be done would have to be done by the owner of the property. A notice was sent to the owner of the property to make the necessary repairs. The owner immediately gave orders to Messrs. Walsh and Son, plumbers, to make the repairs. They sent a workman on Friday, the 22nd of March, to do what was necessary, but defendant would not allow him to go into the house, and said there was nothing the matter with the fittings. The waste of water had been going on from the 4th of March. The Inspector, on visiting the house the previous day, found the waste still taking place, at the rate of 360 gallons per day.

The TOWN CLERK called several witnesses to prove the above facts.

Mr. BRUCE commented strongly upon the conduct of the defendant, and inflicted a penalty of 50s. in each case, including costs.

Miscellaneous News.

METROPOLIS WATER SUPPLY.

The following are the returns of the Society of Medical Officers of Health, on the Composition and Quality of the Metropolitan Waters in April, 1878:—

Names of Water Companies.	Total Solid Matter per Gallon.	Oxygen required by Organic Matter, &c.	Nitrogen. — As Nitrates, &c.	Ammonia. — Saline.	Ammonia. — Organic.	Hardness (Clark's Scale). — Before Boiling.	Hardness (Clark's Scale). — After Boiling.
Thames Water Companies.	Grs.	Grs.	Grs.	Grs.	Grs.	Degs.	Degs.
Grand Junction	18·00	0·089	0·105	0·000	0·009	12·1	8·3
West Middlesex	17·10	0·053	0·129	0·000	0·009	12·6	2·8
Southwark and Vauxhall	18·10	0·046	0·105	0·000	0·008	12·6	2·8
Chelsea	18·20	0·045	0·150	0·000	0·008	12·6	2·8
Lambeth	19·40	0·042	0·164	0·000	0·008	13·2	5·3
Other Companies.							
Kent	23·70	0·014	0·435	0·000	0·003	19·4	6·0
New River	17·40	0·042	0·165	0·000	0·006	12·6	2·4
East London	18·70	0·042	0·155	0·000	0·008	12·6	3 3

Note.—The amount of oxygen required to oxidize the organic matter, nitrites, &c., is determined by a standard solution of permanganate of potash acting for three hours; and in the case of the metropolitan waters the quantity of organic matter is about eight times the amount of oxygen required by it.

The water was found to be clear and nearly colourless in all cases.

C. Meymott Tidy, M.B.

MAURITIUS GAS COMPANY, LIMITED.

The Ordinary General Meeting of Shareholders was held at the London Offices of the Company, 29, Great St. Helen's, on Tuesday, the 30th ult.—W. White, Esq., in the chair.

The Secretary (Mr. A. Hersee) read the following report:—

In submitting the accounts for the past year, the Directors are pleased to report that the operations of the Company, during the above period, have resulted in a further improvement.

In public lighting, there has been an addition of five street-lamps, but the consumption of gas generally for municipal purposes shows a diminution, in consequence of economy introduced by the late Mayor, and the limited duration of the opera season.

A satisfactory increase in the private consumption of gas has taken place, which, if it should prove continuous, will tend to a steady improvement in the Company's position. The condition of the island, owing to better sugar crops, is becoming more prosperous, and encourages the anticipation of a revived demand for gas in Port Louis.

The cost of coal continues moderate, and there is every reason to believe that, in the absence of political complications, a full supply of coal for the present year will be obtained on favourable terms.

The rates of exchange are still very onerous, and there does not appear any prospect of immediate improvement; it is believed, however, that the price of silver will rise shortly, and cause an upward movement in exchange.

The Members of the Resident Committee, Messrs. H. Adam, M. Connal, and J. A. Ferguson, in conjunction with the Manager, Mr. Delachi, have again given their attention to promote the progress of the Company, and to maintain the works in efficiency.

The general revenue account shows a balance of £1929 2s., out of which the Directors recommend a distribution of 1s. 6d. per share, or £3 6s. 8d. per cent., free of income-tax, payable on the 10th of May.

The Director who retires by rotation is William White, Esq., and the retiring Auditors are John Robinson Peill and Thomas Newton Stokes, Esqs., all of whom are eligible for re-election, and they offer themselves accordingly.

The Chairman, in moving the adoption of the report, said: Gentlemen, I have very few remarks to offer you on the present occasion, because nothing of a striking character has occurred since our last meeting. It is satisfactory, however, to be able to present rather a better account, and to show that as yet there is certainly some life in the concern. The increase in the dividend is not very large, but it is a move in the right direction; and although our first expectations are not realized, there is every reason to hope that further progress will result in the coming years. It happened unfortunately to the Company that the Mayor of Port Louis, in his endeavour to secure some popularity, turned his attention to the unsparing reduction of expenditure; and the diminished consumption of gas in the municipal buildings, prisons, fire-engine stations, &c., has affected our revenue to the amount of nearly £200. It is believed that this cutting-down process has now run its course, and we are not likely to suffer any further in this direction. A few more street-lamps have been erected, but the number ought to be increased, if the Municipality were flourishing, and they were not in want of funds. The increase in the private lighting exceeds 7 per cent. That is very encouraging as a sign of vitality; and, as has been before pointed out, the Company are in this position, that they are quite prepared to meet a largely increased demand for gas with the present appliances, if an extended consumption is required. Trade in the Mauritius for some years has not been profitable; but a favourable turn now appears to have set in, and there is a promise that last year's excellent crop of sugar will be followed by an equally good one this year, which will put people in spirits, and be a stimulus to business in Port Louis. The place is isolated for want of telegraphic communication; but an agitation has arisen in favour of the laying of a cable between the Cape and the Mauritius; and, if carried out, I think it will be a great gain to the island, and increase its importance. The circumstances affecting coal are still favourable, and seem likely to remain so, unless the incidence of a war should occasion any rise in freight, or a scarcity of ships. The Australian coal is less liable to spontaneous combustion than the English coal, and, therefore, suits us better; but the advantage of price at the present moment is much in favour of the English coal, and, therefore, we get our supply from this country. The loss on exchange, though not so oppressive as in the previous year, is still serious; and, unless the rate improves, must become more so on the remittances as the profits increase. There is a current impression that the resumption of specie payment by America and other countries will enhance the value of silver, and so occasion a rise in exchange, which we hope will come to pass; but it is not yet apparent in any way. As regards the general working of the concern, every effort is being made to increase the revenue, and to keep down expenditure. The result of the past year's operations, although disappointing, and affording an inadequate return on the capital, shows a marked improvement over the preceding year, which there is every encouragement to believe will be continued. In making these few observations, I beg to move—"That the report and accounts, as now read, be received and adopted;" but before putting the motion to the meeting, I shall be happy to answer any question, as far as I am able to do so, that any of the Shareholders may think proper to ask.

Mr. Stopford seconded the motion.

Mr. Stephenson said he would like to make a suggestion. There was little doubt that the extremely moderate position which the Company occupied had been brought about in great measure by the unprecedentedly low price of freight, and the moderate price of coal that had existed for some time past; and, therefore, in the event of an extreme rise in freight or in coal, it seemed to him that the Company would suffer very materially; because the concern of which the Directors had the management was a small one. The suggestion he wished to throw out for the Board was this: Whether the proper time had not arrived when the works could be disposed of to some other Company who had other stations, and who could manage the concern much more economically, probably, than it could be worked by separate management. If the Directors found that that suggestion could not be satisfactorily carried out, perhaps the better course would be to considerably enlarge the business of the Company by tacking on other places. This would also be better for the Shareholders. Certainly only £2 5s. per share had been called up out of £5, and there was an additional £2 15s. that could be called up, with the sanction of the Shareholders, if it was resolved to take up other businesses. It seemed to him that, instead of the Company keeping themselves in the small unsatisfactory position they at present occupied, if they could search out for other places that might be profitably tacked on to them, and if, for this purpose, the remaining £2 15s. were called up, the position of the Company would be more satisfactory to the Shareholders. He did not wish for an answer; he merely threw out the suggestion, in order that it might be taken into consideration by the Board.

The Chairman, in answer to Mr. Stephenson, said that when the Company were originally instituted, they issued rather more capital than they otherwise would have done, with the expectation of being able to do as Mr. Stephenson had suggested; but the Company paying such a small dividend as they did at present, of course, other concerns were not very anxious to tack them on. Negotiations had been going on with two or three other stations at different places; but the Directors found that, by joining the business of the Company to that of those he had referred to, the position of the Company would be worse than it was at the present moment.

The motion for the adoption of the report was then put and carried unanimously.

Mr. Ward wished to know what was the consumption of coal. He observed that the stock was valued at £2500, and he asked how long it was likely to last.

The Secretary said it would last about seven or eight months.

The Chairman said that when the coals fell to such a low figure the Directors thought it advisable to lay in a good stock; but it was not so much the price of coal that had to be considered, as it was the question of the rise in freights. It should also be borne in mind that there were only certain seasons of shipping. When the ships called at the Mauritius for sugar, was the only time that coals could be obtained, except at exorbitant rates.

Mr. Goodwin asked what the state of the gasholders was.

The Chairman said that there was much more room now than formerly. There were now two gasholders, so that double the business could be done, if necessary; and since the old one had been properly repaired, they both worked uncommonly well, and there had not been a single complaint in regard to them since.

Mr. Stopford moved the re-election of Mr. White (the Chairman) as a Director of the Company. Mr. White had been Chairman ever since the Company were established, and he had no doubt that the concern under him would be as prosperous as all the others with which he was connected.

Mr. Ward seconded the motion, which was carried by acclamation.

The Chairman, in responding, said that this was almost the only difficult thing he had had to do with for some years—at least more difficulties had surrounded the Company than he had anticipated when he joined the Board; but he could not help thinking they would get over all their difficulties, and make the concern something like a fair paying one. Of course if, in the event of war, there was a rise in freights, it was not to be expected that the business would be as prosperous as it otherwise would; but still, under all the circumstances, he thought he could see an improvement.

Mr. J. R. Peill and Mr. T. N. Stokes were re-elected Auditors for the ensuing year.

Mr. Stokes proposed a vote of thanks to the Chairman and Directors for their able management of the affairs of the Company during the past year. The Company was a small concern, and did not go on so well as they could all wish; but this was no fault of the Directors, who, he believed, had done their best.

The Chairman, in returning thanks on behalf of himself and co-directors, expressed his regret that Mr. Smith, one of their number, was not present, the reason being that, having lately suffered from the result of overwork, he was obliged to go abroad for the benefit of his health. As Mr. Stokes had observed, the Directors lost no opportunity of doing all that lay in their power to place the Company in a proper position, which he did not despair of attaining to ultimately.

The proceedings then terminated.

SINGAPORE GAS COMPANY, LIMITED.

The Annual Ordinary General Meeting of this Company was held at the City Terminus Hotel, London, on the 30th ult.—H. P. Stephenson, Esq., in the chair.

The following are the report and accounts presented to the Shareholders:—

The Directors regret they have to report that the progress of the Company during the last half year has not been so satisfactory as hitherto; the loss on exchange has been heavy, and the sales of coke have been very slack. The annexed report of the Engineer and Manager shows further particulars as to the working of the Company.

The Directors going out of office by rotation are—Messrs. Robert Stannard Foreman and William Henry Le Feuvre; and these gentlemen, being eligible for re-election, offer themselves for the support of the Shareholders. The present Auditors, Messrs. William Thomas Morrison and Alfred Williams, retire from office according to the Articles, and, being eligible for re-election, offer themselves to the Shareholders for that purpose.

The balance-sheet to Dec. 31, 1877, appended to this report, shows the financial position of the Company. The Directors have written off for depreciation of works and plant, and off the expenses of first establishment, as per balance-sheet, at the rate of 1 per cent. per annum. The profit for the half year, after writing off these sums, amounts to £1994 4s. 4d., which together with £653 11s. 11d., the unappropriated profit of the preceding half year, makes the available balance £2647 16s. 3d. Out of this sum the Directors recommend the declaration of a dividend at the rate of 7½ per cent. per annum, less income-tax, on the amounts paid up on the preference and original capital; the balance of £324 7s. 4d. to be carried forward to the profit of the succeeding half year; the dividend to be payable on the 20th of May.

Report of Engineer and Manager.

Gas-Works, Singapore, Feb. 26, 1878.

Gentlemen,—By the French mail which left Singapore on the 13th inst., I had the honour to forward you the accounts and statements showing the working for the half year ending the 31st of December last. I trust they will reach you safely, and will be found correct.

During the half year there have been several drawbacks, which have had a tendency to reduce the profits. In consequence of the depressed state of trade in the East, and particularly in Singapore, the consumers have economized the use of gas as much as possible, and several places which previously were large consumers of gas have been partially closed during the half year. The result is a slight reduction in the gas-rental compared with the corresponding period of the year 1876; although, as you may observe, there is an increase over the previous half year of 686.63 dols.

The returns from coke have been less than usual, from the cause mentioned in my last half-yearly report—viz., from there being a large quantity of fuel thrown on the market at low rates, by the salvage sale of the coal, coke, and cinders, resulting from the fire at the Tanjong Pagar Wharf in April last.

Another unfavourable item in the accounts is the loss on exchange, which amounts to 4340.81 dols., on an amount of £3000 remitted.

The present half year has opened with brighter prospects, and at its close I hope to be able to report more favourably on each of these items.

The stock of coke which had accumulated during the half year has been sold for export; and I have entered into an arrangement with the Tanjong Pagar Dock Company to supply them with 40 tons of coke per month, for twelve months; so that there is every prospect that our coke sales will return to their usual satisfactory condition.

In the manufacturing department all is going on well. The loss of gas by leakage and the consumption on the works amounted to 12¾ per cent of the quantity made.

The collection of rental during the half year has been satisfactory, the arrears having been slightly reduced in amount.

During the half year, 52 new houses have been fitted up, and 12 additional public lamps erected. A further number of lamps are ordered to be erected to light the markets.

In conclusion, I would say that I hope to lay before you a more satisfactory report at the close of the present half year.)Signed) E. J. Wells, Manager.

Dr.—*Balance-Sheet, Dec.* 31, 1877.

To Capital—			
£5 paid on 2,000 preference shares		£10,000	0 0
£5 „ 10,572 ordinary shares		52,860	0 0
£2 „ 25 „		50	0 0
		£62,910	0 0
Debenture bonds		900	0 0
Sundry creditors		871	10 9
Insurance reserve-fund		86	6 6
Profit and loss		2,647	16 3
		£67,415	13 6

Cr.—*Balance-Sheet.*

By Cash at bankers, London and Singapore		£922	8 8
Ditto in hands of Secretary		6	14 8
Bills receivable		2,000	0 0
Office furniture		114	14 6
Cost of works and plant, as per last statement	£35,099 13 3		
Add extensions during the half year	391 2 6		
	£35,490 17 9		
Less depreciation at the rate of 1 per cent. per annum	175 10 0		
		35,315	7 9
Purchase of land		1,118	2 8
Retort account		1,107	9 3
Stock on hand		11,276	18 0
Amounts charged to capital for travelling expenses, rent, preliminary expenses, and interest on capital during construction	£10,840 5 11		
Less amount previously written off	904 13 3		
	£9,935 12 8		
Less amount written off this half year, at the rate of 1 per cent. per annum	54 0 0		
		9,881	12 8
Gas, meter-rental, fittings, and sundries under collection to Dec. 1		2,680	12 0
Gas, meter-rental, &c., for the month of December, and gas for public lamps for the half year		2,991	12 7
		£67,415	13 6

Dr.—*Profit and Loss Account, from July* 1 *to Dec.* 31, 1877.

To Coal carbonized	£2,406	2 5
Lime and oxide	20	0 0
Trade and general charges	421	10 2
Rent, rates, and taxes	112	1 0
Directors and Auditors	210	10 0
Salaries and Collectors commission	743	15 10
Wages	403	19 6
Interest on loans and debentures	268	15 9
Loss on exchange	726	10 10
Bad debts and allowances	94	16 9
Retort account	100	0 0
Meter repairs and renewals	38	8 4
Depreciation on works and plant, and expenses of first establishment written off	229	10 0
Balance—profit for appropriation	2,647	16 3
	£8,423	16 10

Cr.—*Profit and Loss Account.*

By Balance at profit and loss, June 30, 1877	£2,950	1 5
Less amount declared as dividend, after deducting income-tax on, ordinary and preference shares	2,296	9 6
	£653	11 11
Gas and meter rental	6,197	0 2
Products, profit on fittings, and sundries	1,573	4 9
	£8,423	16 10

The Chairman: Gentlemen, I have to move that the report, with the balance-sheet attached thereto, be received, adopted, and entered on the minutes. First, as regards our capital account, compared with the corresponding half of last year, you will find that we have received £1373 more capital in shares; but we have paid off over £3000 worth of bonds. That, so far, is very satisfactory. We have about £530 more creditors; and, on the other side of the account, we have £1900 less cash. These are the prominent features of the capital account. As regards the profit and loss account, nearly all our items remain the same as before, with this exception, that our loss on exchange is £340 more; our gas and meter rental is £240 less; and our products, profits on fittings, and sundries, are nearly £300 less. This accounts for the difference in the balance-sheet which we submit to you on the present occasion. We have two disagreeable items—one is the item of exchange. During the last year we have lost nearly £1000 by exchange. Many men, with much more talent than I have, profess to be totally ignorant of the whole of the reasons for the fall in the price of silver; other men, with less talent than they, profess to know all about it; but I must admit, myself, that none of them have shown themselves to be true prophets; and, as I have told you on former occasions, the only thing we can do is to meet the disagreeable thing as it comes before us, and deal with it the best way we can. I do not see any prospect or probability of any immediate change; and, therefore, we must just "grin and bear it." Another disagreeable item is the reduction of gas-rental. But I think we may have hope as to this, for I presume all of you know that a depression in trade exists, not only here in England, but over the Continent and the whole world; and no doubt the reduction of rental has arisen from the extreme depression in trade, and in the shipping interest. That, in the last half year, up to June, we rather recovered from; and had I been comparing the gas-rental of this half year, with the gas-rental of the half year ending June, it would have shown an increase. Then I have referred to the loss in coke. That arises entirely from an exceptional circumstance. The large quantity of coal burnt and half burnt in the fire at the Tanjong Pagar Wharf having been sold by auction in the district, the whole place was inundated with cinders, half-burnt coke, and half-burnt coal, and for a time this entirely destroyed our coke market. I am, however, glad to say that we see some signs that this hostile operation against the sale of our coke is about to subside. I believe that the majority of the cinders and burnt coke sold at the Tanjong Pagar Wharf are now very nearly consumed, and we are beginning to have a better trade for our coke, and a better price. Notwithstanding all these drawbacks, we are able to pay you the usual dividend; but no doubt those who have gone into figures will see that the amount we pay in dividend is about £300 more than the profit we have made during the half year. That £300 has been met out of the balance which we prudently, on a former occasion, brought forward; so that we are now able to pay your dividend, and still carry a balance forward, although not so large by £300 as the balance that was brought forward. With these observations, gentlemen, I have to move that the report, with the balance-sheet attached thereto, be received, adopted, and entered on the minutes.

Mr. Foreman seconded the motion.

Mr. Smith said he observed that the interest on debentures and loans was equally as large, if not somewhat larger, than in the corresponding half year.

The Chairman explained that the reason for this was that, in order to clear off the debentures, the payment of the interest was anticipated. In order to make up the amount in the balance-sheet, some of the interest of the succeeding half year was included. This, however, would not appear next half year.

Mr. Smith asked if the new issue of shares would really take the place of the debentures.

The Chairman said that it would, with this exception, that the amount raised on new capital, as compared with December, 1877, was only £1373, and £3000 worth of debentures had been paid off.

Mr. Rice said he observed that there were still 25 shares remaining with £2 paid on them. He was in hopes that these would have been struck off the balance-sheet.

The Chairman said no doubt they would be struck off the next balance-sheet. They were 25 shares taken at Singapore, and the gentleman who had them was away from Singapore at the time. They were not paid up now; but orders had been given to make the call, and they would have to be paid up.

Mr. Hewetson said it appeared from the report that the loss of gas, by leakage and the consumption on the works, amounted to 12¾ per cent. of the quantity made. He wished to know what proportion of that was consumed on the works, and what was the proportion lost. It appeared to him that it was a large item.

The Chairman said he could not afford the information; but if he were to give it as his opinion, he would say that probably one-twelfth of it would be consumed on the works.

Mr. Hewetson considered the leakage was very great.

The Chairman did not think it was very great for such a considerable district with mains, seeing they were foreign works.

Mr. Hewetson still held the opinion that it was enormous, and demanded the attention of the staff at Singapore.

The Chairman remarked that in England it was thought a favourable circumstance if the leakage were under 10 per cent. in provincial Companies. The instances in which it was less were very rare.

Mr. Hewetson said in the case of The Gaslight and Coke Company it was less.

The Chairman said that that was only within the last 18 months.

Mr. Smith said he was interested in several Gas Companies, and he did not know any one whose leakage and condensation were less than 12 per cent. In all suburban and straggling districts the condensation was very large.

The Chairman remarked that if it were possible to transfer the City of London to Singapore, he thought a pledge could be given that the leakage of gas would be less than it was at present; but in the present circumstances—and he had had considerable experience in foreign and provincial Companies—he did not think 12 per cent. was an excessive leakage; although, perhaps, it could be slightly reduced.

Mr. Smith said it was much less than he expected. If it had been 15 per cent. he should not have been at all surprised.

The motion for the adoption of the report was then put and carried unanimously.

The Chairman moved—"That a dividend be declared to the preference and ordinary Shareholders at the rate of 7½ per cent. per annum, less income-tax in both cases, on amounts paid up on their shares from the respective dates of payment to Dec. 31, 1877; such dividends to become payable on the 20th of May."

Mr. Foreman seconded the motion, which was carried unanimously.

The retiring Directors were re-elected, as also were the retiring Auditors. Ten guineas each, as in previous years, were awarded to the Auditors for their services.

The Chairman proposed a vote of thanks to Mr. Wells, the Company's Manager and Engineer, for the energetic and careful manner in which he had managed the affairs of the Company.

Mr. Foreman seconded the resolution, which was carried by acclamation.

On the motion of Mr. Rice, seconded by Mr. Smith a vote of thanks was heartily accorded to the Chairman, Directors, and Local Committee at Singapore, for their able management of the Company's affairs during the past year.

The Chairman, in responding, said that the Directors had done their best in the past, and would endeavour to do so in the future. There had not been what he might call a very extraordinary success attending their efforts, but he thought they were eminently respectable. Their dividends kept at the respectable figure of 7½ per cent., and as long as they did that there was no reason to complain. If the Directors could see their way, carefully and clearly, to go a little above that at some future time, the Shareholders might depend upon it that it should be done in the interest of both parties.

Mr. Foreman proposed, and Mr. Rice seconded, a vote of thanks to Mr. King, Secretary and Engineer of the Company. The vote was carried unanimously.

Mr. King, in a few words, returned thanks for the compliment.

The proceedings terminated with the usual vote of thanks to the Chairman.

Ottoman Gas Company, Limited.—At the ordinary meeting, on the 18th ult., the Directors reported that the gas-rental for the year ending the 31st of December last amounted to £6878 14s. 3d., and the net profit (after paying interest on debentures) to £2095 0s. 10d., which, added to the balance brought forward, made the sum of £2528 16s. 11d. This sum the Directors proposed to deal with as follows:—First, in payment of a dividend of 7 per cent. on preference shares, and, secondly, of 2 per cent. on ordinary shares. They further proposed to write off from the preliminary expenses account £500, leaving a balance to carry forward of £518 15s. 8d. During the past year the Directors have paid off debentures to the extent of £1500, and they have made a call on the preference shares to the extent of £1000. The Board, deeming it expedient to fill up one of the vacancies occasioned by the retirement of former Directors, have invited Mr. Alexander James Dove to join the Board.

ON THE ARRANGEMENT AND CONSTRUCTION OF GAS-WORKS.

By Mr. H. Ellis Hill, A.I.C.E.

[A Paper read before the Civil and Mechanical Engineers Society, on Thursday, April 11, 1878.]

Mr. President and Gentlemen,—The subject of gas-making and supply is so large and important, that I have thought it best in this paper to treat in general terms of the arrangement and construction of gas-works, by way of introduction, to be followed, I hope, in future sessions, by papers from other members on the various special apparatus.

The use of coal gas for lighting and heating purposes, although now so general, is of comparatively recent growth, at the beginning of the present century being scarcely known; the wise men of that day prophesying not only its speedy departure, but also that terrible disasters would occur while it was in use; while a clever Member of Parliament said it would be an impossibility to get a light without a wick. Since then ideas have entirely changed, and now gaslight has become nearly universal, many millions sterling being employed in gas-works, giving occupation to thousands of men, and taxing the abilities and energies of many of our best-known engineers.

The first consideration in connection with the design of a gas-works is, of course, obtaining a suitable area and site; and this is of the utmost importance, not only as bearing on the first cost of the works, but also—and this is, perhaps, of still more importance—on the working expenses for manufacture, so long as the works may be in existence.

Having estimated, then, the requirements of the district, and the capacity of the works, not only to supply present needs, but also the probable quantity required within, say, the next ten years, an area should then be obtained large enough to contain the works, and also to allow for the probable extension, so that new buildings and apparatus may be conveniently added as required. This area should be easy of access by rail, and also, if possible, by water. A railway siding should run into the works, so that coal could be delivered directly into the coal-store, and empty trucks returned to the line with the minimum amount of labour. The works should also—and this would generally follow if near a river—be at a low level compared with the district to be supplied. Sometimes great difficulty is experienced, if part of the town is higher and part lower than the works, in keeping a uniform and constant supply to both parts. Gas, having a natural tendency to rise, would supply the higher levels; but the lower parts, unless supplied from a different holder, and under pressure, would often be without any. But, while it is of advantage to obtain a low level for the works, care must be taken that the district is not likely to be inundated by floods, as was the case at some large works I recently visited, where the utmost difficulty was experienced in keeping the flood waters from the retort furnaces.

The site having been decided upon, the all-important question of arrangement would then require that all the knowledge and ingenuity of the Engineer should be brought to its proper consideration. All the apparatus should be constructed and arranged so that the coal may be easily received in the stores, and then passed on from stage to stage until the purified gas is safely stored in the holder ready for distribution into the town mains.

Now, Mr. President, having briefly introduced the subject, it will probably be more convenient to the members, for the purposes of discussion, if, instead of laying down abstract principles and general formulæ, I put before you model works I have designed for a town of a given size, and work out and describe the apparatus in the order of its procedure when gas-making, pretty much in the same way an engineer would have to do if called upon to design such works.

First in order and importance, as regulating the size of the whole works, is the retort-house and fittings. I have taken, in this instance, a town of 5000 inhabitants, and have designed the works to be fully equal to their present demands, and with space for easy extension to twice that capacity.

For small works of this size the retorts would be what are called single settings—that is, open at one end only, the benches being about 10 feet in length from front to back, and the retorts 16 inches in diameter. The house should be 30 feet clear span, and about 20 feet high to the wall-plate, covered with a slated roof on wrought-iron trussed principals, and well furnished with louvre openings for ventilation, the length of the house being regulated by the number and size of the retort benches. A space in front of the retorts, about 8 feet in width and the whole length of the benches, should be paved with fire-bricks on edge, laid with a gentle slope towards the furnace, so that water used in slaking coke may run into the ash-pit, the remainder of the house being paved with 4-inch flagging. The retorts may be either round, oval, or D-shape; the two latter give the best carbonizing results, but are not so strong as the round; so that in small works where there would not be many spare benches, the round ones would generally be preferred. The number of retorts required would be found by the following rule:—For a small town a fair allowance would be 1800 cubic feet of gas per head of population (so that for 5000 people 9 million cubic feet of gas) per annum. This, divided by 180 days—a number found to give a good practical result—shows 50,000 cubic feet as the average daily consumption; but as the heaviest day's make must be allowed for, this would probably be half as much again, or 75,000 cubic feet. Each retort would produce about 4600 cubic feet of gas per day of 24 hours. Thus 17 retorts would be required for the heaviest day's make. Add to this number 25 per cent. for repairs; the retort-house should, therefore, be constructed for 21 or 22 retorts. Supposing a bench to be set with seven retorts—a very good number—three benches would be required, or, perhaps, a preferable arrangement would be as shown on the plan—that is, two benches of sevens, one of five, and a smaller one of three retorts, thus giving increased facilities for regulating the make between the small consumption of mid summer and the heaviest winter's day, as a combination of either 3, 5, 7, 8, 10, 12, 14, 15, 17, 19, or 22 retorts may be used. The retorts are charged by means of a long scoop, with about 2 cwt. of coal, and allowed to carbonize between four and five hours—a good method being to give five charges per 24 hours. The gas, as made, is taken from the retorts by an ascension-pipe above the projecting mouthpiece, generally 5 inches internal diameter at the lower end, and tapering to 4 inches internal diameter at the top. The gas then passes at a considerable distance above the retorts through a cross, or H-pipe, and hydraulic dip, into the hydraulic main—a simple and beautiful contrivance for carrying off the gas. The main should be made, for lightness and strength, of wrought-iron plates, bent to the required shape—generally U section—having a flat cover, with opening to admit the dip-pipes. The main is generally carried by brickwork or brackets from the top of the benches. The lower portion of the hydraulic main is charged with tar and liquor at a sufficient height to immerse the lower end of the dip-pipe, and form a seal, so that the gas which forces its way, or is drawn, from the retorts cannot return. In some cases the hydraulic main is constructed in short lengths or sections, the gas and tar being taken off by a false main running parallel to it.

The retort-benches are constructed principally of fire-bricks, having a furnace below, with openings or flues passing round the retorts for the heated gases from the furnace to carbonize the coal in the retorts—a single flue passing from the end to the main chimney stack. Through bolts are built into or over the stack, to prevent it splitting with the varying temperatures. Before re-charging the retorts, the residual coke is drawn out and slaked, part being used as fuel in the furnace, and the remainder stacked in a convenient place for sale.

In connection with this part of the works should be built the coal stores. The preferable way is to put the building parallel to the retort-house, and opposite the front of the retorts. The size would, of course, vary with the facilities for obtaining coal supply; but, in ordinary cases, a storeage capacity equal to six weeks heavy consumption should be allowed for. The building should be so arranged that the full coal trucks from the railway could run in and drop their contents on to the floor of the stores, until the coal reached the level of the rails. It could then be thrown over the sides of the trucks on each side, and walled up to the level of the wall-plates. The lower part of the wall, between the stores and retort-house, should have openings through which coals could be drawn for use in charging the retorts. The building in the design has been shown 22 feet clear span, and the same height and length as the retort-house. The rails for the trucks would be carried on columns and girders for the length of the building, the top of the rails being 12 feet from the ground level, to allow loaded trucks passing under the tie-rods of the roof. The calculations for size of stores are very simple. Taking 75,000 cubic feet as the heaviest day's make, and a ton of coal as yielding 9500 cubic feet of gas, a day's consumption would be 7·9 tons by 42 days = 332 tons, at 43 cubic feet per ton, equals 14,276 cubic feet of space required for storeage of coal. By having a large coal-store the works would not only be independent of fluctuations in the supply, but the coal would get thoroughly dry before being required for use.

The coal having been brought from the railway to the stores, and thence to the retorts, the products of carbonization—that is, the illuminating gas and its impurities, and the condensed tar and liquor—pass from the retorts through the hydraulic main to the condenser to be gradually cooled down to as nearly as possible the atmospheric temperature.

Condensers are of various designs; those known as surface condensers are the most general and the simplest in their action. These are of three well-known types; that is—

1. The series of horizontal, or nearly horizontal tubes, the lower ones immersed in water, in which the gas passes backwards and forwards from the top to the bottom, being gradually cooled in its passage by radiation through the metal of the tubes.

2. The vertical pipes, fixed on a rectangular iron box, in which the gas traverses alternately up and down through the series, until the temperature is sufficiently lowered; but perhaps the simplest and best form is the vertical annular condenser, consisting of a series of double tubes, side by side, with annular spaces between them. These tubes are fixed at the lower ends on to a rectangular box by short horizontal branch-pipes to the top, or by diagonal pipes from top to bottom. The gas from the hydraulic mains, passing into the annular space at one end of the condenser, is brought in contact with two cool surfaces—that is, the outer and inner tube, both exposed to the atmosphere. As the gas cools, the tar and liquor carried with it are deposited, and trickle down the sides and into the chamber beneath, and from thence to the tar-well, the series of tubes being sufficiently large to give the required amount of cooling surface. The advantage of this condenser is that a continuous current of air is kept up through the inner tube, caused by the cold exterior air forcing upwards the warmer air from inside the tube. In warm weather, if the condenser is exposed to the direct action of the sun, water may be allowed to play on the outside tube, to keep it cool; and in cold weather the inner tube may be closed, or partially closed, to regulate the supply of cold air. In calculating the size of condensers, it is usual to allow 150 superficial feet of cooling surface for each 1000 cubic feet of gas passed through per hour; so, for works of the size illustrated, that is 75,000 cubic feet for the heaviest day's make, or 3125 cubic feet per hour, a condenser with 470 superficial feet of cooling surface would be required, or say two condensers, each 2 feet 6 inches outside diameter by 18 feet high.

The next apparatus in order is the exhauster, for drawing the gas from the condenser and passing it on to the scrubber, for lessening the pressure, and for preventing the deposition of carbon in the retorts. There are two distinct types of exhausters in general use, the rotatory and reciprocating, each having advocates, the former, I believe, giving generally the better results. The rotatory exhauster consists of two cylinders, the outer one fixed to a bed-plate, and having within it a smaller one revolving on a shaft set out of centre. Projecting from the small cylinder is a slide actuated by a pin working in a groove in the outer casing. As the inner cylinder revolves, the slide filling the space between it and the casing causes a vacuum behind, into which rushes the gas from the condenser, and at the same time the gas in front of the slide is forced on to the scrubber; the theoretical objection to this form being that they do not exhaust steadily, as the work done in similar times varies with the varying length of the diaphragm slide between the two cylinders. The reciprocating exhauster is similar in principle to a horizontal blowing-engine, the piston of the exhausting cylinder being worked either direct from the end of the steam piston-rod, or by a connecting-rod from the crank-shaft; the action being, of course, the reverse of that in the steam-cylinder—that is, the piston causes in its travel a vacuum behind it, and the gas from the condenser rushes in, and at the return stroke is forced through what would be called the exhaust port of a steam-cylinder on to the scrubber. In single exhausters of this type, the same objection would apply as to the rotatory type, but they are generally made with two exhausting cylinders, the pistons being driven by cranks set at right angles, so as to equalize the work done as nearly as possible to the traverse of the steam piston.

From the exhauster the gas is passed to the scrubber, to remove the ammonia. The scrubber, as generally constructed, consists of a large upright cylinder with an inlet-pipe at the bottom and an outlet at the top. Shelves are arranged inside, covered with coke, tiles, brushwood, or other porous substance; or, as is probably the best plan, filled with thin boards set on edge and crossed in layers, the boards being about three-eighths of an inch thick, with about the same amount of space between. At the top of the scrubber is an apparatus for distributing water or ammoniacal liquor over the surface. This water or liquor, trickling down through the pores or spaces of the materials, absorbs the ammonia from the ascending gas. When coke is used it must be periodically renewed, as the pores get choked with impurities; but as far as I know this does not seem necessary with the boards, some scrubbers having been in work some years without requiring any change of filling. This stage of gas purification has become more important during the last few years because not only is an impurity taken from the gas, but a valuable article of commerce is obtained. A scrubber requires a capacity of 150 cubic feet for each 1000 cubic feet of gas passed per hour, and 15 gallons of water per ton of coal carbonized. So for works of the size now described the scrubber should be 6 feet diameter and 18 feet high.

In connection with the scrubber and condenser is a tar and liquor tank, into which the tar and liquor, distilled from the gas in the condenser and scrubber, pass for storeage until sold. The tank, or well, may be of brick-work, concrete, or iron, sunk in the ground, the top being level with the

surface. The size should be equal to eight weeks storeage, taking 25 gallons as the quantity yielded by each ton of coal carbonized. The size shown on the plan is 20 feet by 15 feet by 12 feet deep.

Following the scrubber are the purifiers, where the gas is completely purified before entering the holder. They are generally arranged in sets of four—three being in use and one at liberty for recharging—a centre-valve being placed between them to direct the passage of gas in any required order through the purifiers. The usual pattern of purifier is like a large box, constructed with cast-iron ribbed plates, bolted together and caulked at the flanges. Ledges are cast inside, on which rest wood sieves, covered with lime or oxide of iron. In the Metropolitan district, where the Act of Parliament is very strict as to the appearance of carbonic acid, lime is necessarily used in purifiers, either wholly or in conjunction with oxide; but in the Provinces oxide is very often the only material used. The cover of the purifier, which is removable, is made to pass over the sides, dipping into a recess nearly filled with water, acting as a seal to prevent the escape of gas. The gas from the scrubber is introduced at the bottom of the purifier, and, in passing through the purifying agent, parts with its carbonic acid and sulphuretted hydrogen, the process of purification being similar, whether the agent employed be lime, oxide, or a combination of the two. Taking, for example, a set of lime purifiers, in each casing would be an arrangement of sieves—generally four or five placed one above the other—each spread with a layer of slaked lime 3 or 4 inches in thickness. The gas entering from an inlet-pipe at the bottom, passes through each layer and down an outlet-pipe at the top, leaving a portion of its carbonic acid and sulphuretted hydrogen in combination with the lime. The gas then passes through the centre-valve to the second purifier, and then to the third, by which time it should have obtained the required state of purity. When the first purifier has become too foul for further use, the valve-cover is lifted and turned a quarter turn, the second purifier then becomes the first in order, and the spare one, which had in the meantime been refilled, brought into use, as the third one—the one that has now been thrown out of action—is emptied of its foul contents ready for recharging when required. When oxide is used, the sieves would be less in number, and have thicker layers. The great difference between the two systems is not so much in the action as in the residue, which, in the case of lime, becomes an intolerable nuisance while it remains on the works; and, although it is possible in country districts to sell it as manure, in large towns it is often difficult to get rid of it even by payment; while in the case of oxide, the spent material may be laid on the ground, and after turning over for two or three days is again fit for use. Before emptying a purifier, the cover has to be lifted and taken away. A very usual plan of doing this is to have rails supported on brackets running along the length of the house over the purifiers. On these rails is a traveller-frame with a traversing hand-crab or with a vertical screw, to which are slung four chains hooked into shackles at the corners of the cover, by which the cover may be lifted and carried over the next purifier. This method is only applicable where the weight of the cover is not great; but in large works where manual labour, both in lifting the covers and filling the purifiers, must be as much as possible dispensed with, different systems have been adopted. The latest and most complete arrangement of the kind for this purpose, and of which, by the kindness of my friend, Mr. Morley, of the Salford Corporation Gas-Works, who has also supplied me with much other valuable information on the subject of this paper, I am able to give particulars, is now being applied to some new purifiers, 30 feet square, at those works. In this case a line shaft runs along two sides and one end of the purifier-house, driven by a belt from an engine below, the lifting machinery for each purifier consisting of four square-thread screws, one at each corner, working in worm-wheel nuts, attached to the beams carrying the purifiers. These wheels are actuated by worms on shafts alongside the purifier, the four shafts being connected at the corners by mitre gearing, so that when set in motion the four screws are simultaneously turned, and the cover raised to the required height. When high enough, four carrier-wheels are inserted into brackets on the cover, the screws are withdrawn, and the cover, running on wheels, is hauled along on the edge of the purifier on to the next one, a short rail being placed between them to make a continuous line. In connection with this apparatus is an arrangement for lifting the oxide and recharging the purifiers. Between each pair of purifiers is an elevator consisting of a series of iron buckets on links, forming a continuous chain, carried round a drum at the top of the house, the lower end dipping into an elevator-trough on the ground floor, into which oxide is tipped from barrows. When a purifier requires charging, the elevator is put into motion by worm-wheel gearing, and takes up from the oxide trough a continuous supply, delivering it into a hopper attached to a swinging shoot, so arranged that it may be brought over the centre of the purifier being charged, the attendant merely having to spread it evenly upon the surface. The whole of the machinery for lifting the covers and filling the purifiers is to be driven by an engine with a 10½ inches diameter of cylinder, and 24 inches stroke. The boiler will be 5 feet 6 inches diameter, 15 feet long, with 2 feet 9 inches tube. To calculate the size of purifiers, the simplest rule is, supposing there to be four to the set, three always in work—multiply the heaviest day's make in thousands by ·6, for the superficial area of each purifier.

From the purifiers the gas passes through an instrument which, although having nothing to do with either the manufacture, purification, or storeage, is an essential part of all well-regulated gas-works—that is, the station-meter for measuring and registering the quantity of gas made. Its construction is similar to an ordinary service-meter, but, of course, large enough to pass the total make of the works.

The gas now being made, purified, and measured has to be stored previous to distribution to the town. For this purpose a gasholder and tank are required.

The tank is generally a large circular pit, sunk in the ground, and lined with brickwork backed with clay puddle, finishing at the ground level with a stone coping. Until recently, except were iron tanks were used, brickwork was the only material used for tanks. But a few years since, Mr. Livesey, of the South Metropolitan Works, who has had the honour of introducing many improvements into gas-works, constructed a concrete tank with a brick lining, and afterwards one entirely of concrete, and without any puddle backing, and with so much success that, I believe, concrete is destined, from its adaptability and cheapness, to supersede brick for this work. At one side of the tank is a recess to receive the inlet-pipe from the station-meter and the outlet-pipes to the street-mains. Bed stones are placed on the bottom of the tank to receive the runner guides for the holder, and at the coping for the columns or stanchions.

The general appearance of a gasholder is so well known as to need no description here. Its construction is, however, a matter of great importance, being a costly article, and requiring more skill to construct and erect than any other portion of gas-works plant. There are two kinds of holders—the single and the telescopic—the former cheaper as to first cost, but the latter, by taking up less ground, would probably be found cheaper in the end.

The holder shown on the plan is 54 feet diameter, double lift, each 17 feet 6 inches high, the plates varying in thickness according to position; the crown plate being three-eighths of an inch thick, the inner and outer circles No. 13 Birmingham Wire Gauge, the remainder of the roof sheets No. 14 B. W. G., the top and bottom tiers of the sides No. 14 B. W. G., the others No. 15; rivets for the thin plates quarter of an inch diameter, 1 inch pitch. At the bottom of the inner lift is a cup to receive the dip of the outer lift; the cup and dip are similar in construction, but inverted in position, and may be made by rivetting to the shell of the holder, and to a vertical plate, a piece of channel iron or double-angle iron, or a plate may be bent to the required form. When in action the cup would be partially filled with water to act as a seal, to prevent the escape of gas between the lifts; the sides of the holder are generally stiffened by vertical truss bars to prevent the sides buckling when resting on the bottom of the tank; the cover is also, in most cases, trussed for the alleged purpose of keeping the crown in its proper shape when not distended by gas. This point, however, is now being warmly discussed, the result of which will, I think, be that trussed covers will soon belong only to the past; for it seems contrary to all ideas of correct designing that a heavy trussing should be attached to and carried up and down with the cover in all its journeying, and continually straining it, merely because it may be wanted to keep the cover in shape when the holder is empty, which could be more simply and effectually done by erecting a fixed light in the tank to receive the cover. The holder is kept in a vertical position by guide-pulleys running on guide-bars in the tank, and continued up the face of the columns.

For economical working, and for the peace of mind of the Manager, the holder should be large enough to contain 24 hours maximum make, and furnished with, say, one column to every 10 feet diameter of holder.

There is nothing very special about the ordinary column, except that it is specially unadapted for the work it has to do, and will possibly, in the future, give place to the light but stiff wrought-iron lattice columns now largely used in America.

From the holder the gas is taken by an outlet-main through the governor—an apparatus for regulating the pressure—into the town mains and service-pipes, for use as required.

Within the boundary of the works there should, of course, be a manager's house and the necessary offices, stores, fitting-shop, &c.

I have made no particular mention of the arrangement of bye-passes, by which, on opening and closing different valves, the gas may be made to pass by, instead of through, any apparatus which may be temporarily disabled.

[The paper was illustrated with diagrams of the various apparatus and plant employed in gas-making; and also a model plan designed specially to meet the requirements of a town having a present population of 5000 inhabitants. A discussion followed, which was taken part in by the President, Messrs. Walmisley, Coates, Thorneloe, Bancroft, and Feeny.]

Quality of the Birmingham Gas.—Mr. Jackson reports that, during the month of April, at the four gas-making stations of the Corporation, he made 14 examinations of the illuminating power of the gas supplied to the Borough. The maximum light in sperm candles was 17·68; minimum, 15·79; average, 17·06. The Parliamentary standard is 15 candles, with Sugg's No. 1 "London" burner.

Compulsory Purchase of Water-Works.—A correspondent has added the following note to the information we recently gave from the *Northern Echo*:—"You mention the compensation for the compulsory sale of the Stockton and Middlesbrough Water-Works. It is worth while referring to the subject from a financial point of view. The maximum statutory dividend of the Company is a little over £18,500. They offered to sell it, so reports goes, for £550,000—at any rate for less than £600,000; but the Corporations persisted in fighting them by Act of Parliament. They got compulsory power of purchase—the first Act ever granted—but they had to pay 25 years purchase of the statutory dividend, *plus* compensation to be awarded by arbitration for compulsory sale and for prospective improvements. The Arbitrator has awarded £213,000 in addition to the £466,000, the 25 years purchase, so that the Corporations have to pay close upon 37 years purchase, besides taking over debts, &c.—a caution for future compulsory purchasers! The costs of the Act are estimated at over £60,000. The rateable value of the two towns is only £340,000."—*Financial Opinion.*

Newbury Water-Works.—The public opening of these works took place on the 23rd ult. The Newbury Water Company were formed in 1877, with a capital of £20,000, in 4000 shares of £5 each. The source of their water is a well dug in the chalk in the valley at Northcroft, a short distance from the town. It is only 14 feet deep from the surface and 7 feet in diameter. It was originally intended to carry it down to a greater depth, but at the depth of 14 feet a strong spring was struck coming in from the chalk, and which yields from 20,000 to 34,000 gallons per hour. The well affords an instance of one of those peculiar springs which are occasionally met with in the chalk formation. On the 15th of May last year, this spring was struck in sinking the well, and was found to yield 34,000 gallons per hour at a depth of 1 foot 6 inches from the bottom of the well, the yield gradually diminishing to 19,320 gallons at a height of 5 feet from the bottom. It was at first supposed that this was the valley water coming up through the gravel, and samples were, therefore, submitted to the late Dr. Noad, F.R.S., who pronounced it to be pure chalk water, similar to that obtained from the North Kent Water-Works at Crays. Dr. Noad stated in his analysis that the water was somewhat hard, but as a beverage and for domestic use perfectly unexceptionable. From the well the water is pumped to a reservoir situated at Speen, at a height of 110 feet above the surface of the well. The pumping-station consists of an engine and boiler-house built of red brick, with strings of blue brick, and set off by ornamental stonework. The chimney shaft is about 40 feet high, and has an ornamental stone cap. At present there is only one engine and boiler on the works, but space is left in the building for another of each, which will be added when the increased demand for water renders it necessary. The water is lifted by four pumps, having cylinders 9½ inches in diameter, and 2 feet stroke. The pumps are driven by a vertical engine of what is known as the Grover "Britannia" type, having an overhead cylinder 12 inches in diameter, with 2-feet stroke. The engine is of 12-horse power nominal, and is supplied with steam from a Cornish boiler, 16 feet long and 5 feet diameter, with a flue of 2 feet 7 inches diameter. With this machinery, over 16,000 gallons of water per hour are lifted into the reservoir at Speen. This reservoir, which is not quite finished, is constructed of brickwork in cement, the sides sloping with a batten of 3 feet to 1 foot. It is to be covered in with brick arches, and is provided with a valve chamber, 10 feet by 6 feet. This reservoir is 42 feet long, 30 feet wide, and the height of the final water level in it will be 15 feet from the bottom; it is at present 10 feet. The reservoir is capable of containing about 110,000 gallons. The brickwork at the bottom of the walls is 3 feet 9 inches thick, working up to 2 feet 3 inches at the top, whence the covering arches will spring. The reservoir is situated at such a level as to command the whole of the town of Newbury, which has a population of about 10,000. Pipes have been laid down throughout the greater portion of the town, and the services are being rapidly put in. The supply will be constant. The Engineer of the Company is Mr. J. W. Grover, M. Inst. C.E.

SULPHUR PURIFICATION.

Mr. F. J. Evans, a Director of The Gaslight and Coke Company, and late the Engineer-in-Chief of that Company, has, in conjunction with Mr. W. T. Sugg, Gas Engineer, of Westminster, just completed a patent* for an invention, the chief object of which is stated by them to be "to effect the complete removal of the sulphur compounds contained in coal gas as it leaves the retorts, and thereby to increase the illuminating power of the gas."

In order to attain their object, the patentees propose to utilize the ammoniacal liquor produced in the distillation of coal, and to employ the ammonia derived therefrom as a purifier of the gas.

The removal of the sulphuretted hydrogen from the gas is, as is well known, a comparatively simple matter; but the removal of the bisulphide of carbon, or fixed sulphur compounds, has hitherto been the great difficulty with gas engineers.

In applying their invention to an established work, the patentees propose to jacket, if necessary, for the whole or a portion of their length, the pipes leading from the several retorts to the hydraulic main, or the pipe into which the gases generated in the several retorts are discharged, the object being to maintain the gas at a temperature of some 200° on its delivery to the hydraulic main. Into the hydraulic main, or its equivalent pipe or chamber, ammonia is admitted, either in the form of vapour or liquid, in such quantity that the carbonic acid and the sulphur compounds (sulphuretted hydrogen and bisulphide of carbon contained in the hot gas) will, as the gas is subjected to a washing process, become neutralized.

To obtain the ammoniacal vapour and solution, the gas liquor produced in the manufacture of coal gas is run into a boiler, and the ammonia compounds are driven off therefrom by the application of heat. These compounds, together with the steam generated, are led into vessels, such as are ordinarily used for the purification of gas.

Fig. 1 shows one arrangement for this purpose. A is a boiler for distilling off the ammonia, and *a* a pipe leading from the boiler to the first purifier, B. This purifier is supplied with oxide of iron, and is connected by a pipe, *b*, with the second purifier, C, containing lime. The pipe, *c*, leads from this purifier to the first of a series of closed condensing vessels, D, which are partly filled with water. These vessels are connected

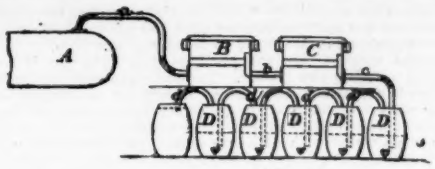

FIG. 1.

together by dip-pipes, *d*, which conduct the surplus ammonia from one vessel to the other. The ammonia as it enters the first vessel is taken up by the water contained therein, and when the water is saturated, the ammonia passes off to the second vessel, and so on to the whole series, saturating in turn the water supplied to the several vessels. A pipe leading from the last closed vessel dips into water contained in an open vessel, and when an escape of ammoniacal gas from this vessel is observed, the liquor from the condensers is drawn off, and a fresh supply of water is admitted to the condensers. The oxide of iron in the purifier B will absorb the sulphuretted hydrogen carried over with the ammonia, and the lime in the purifier C will absorb the carbonic acid. The ammonia thus obtained will be in the form of a strong caustic solution, and is then ready for use in the hydraulic main. The supply of this solution is adjusted to suit the amount of gas which is passing from the retorts. When sufficient ammonia is presented to the gas to neutralize the acid compounds, the gas will be deprived of the carbonic acid, sulphuretted hydrogen, and the bisulphide of carbon, or fixed sulphur compounds, contained therein.

When employing ammonia in the state of vapour, the lime purifier is connected with the hydraulic main or its equivalent, and the ammonia is thus brought into direct contact with the hot gas.

The apparatus employed by Messrs. Evans and Sugg, in effecting the purification of gas according to this invention, is one which has been subsequently patented by Mr. Sugg,* of which the annexed engraving, fig. 2, is an illustration:—

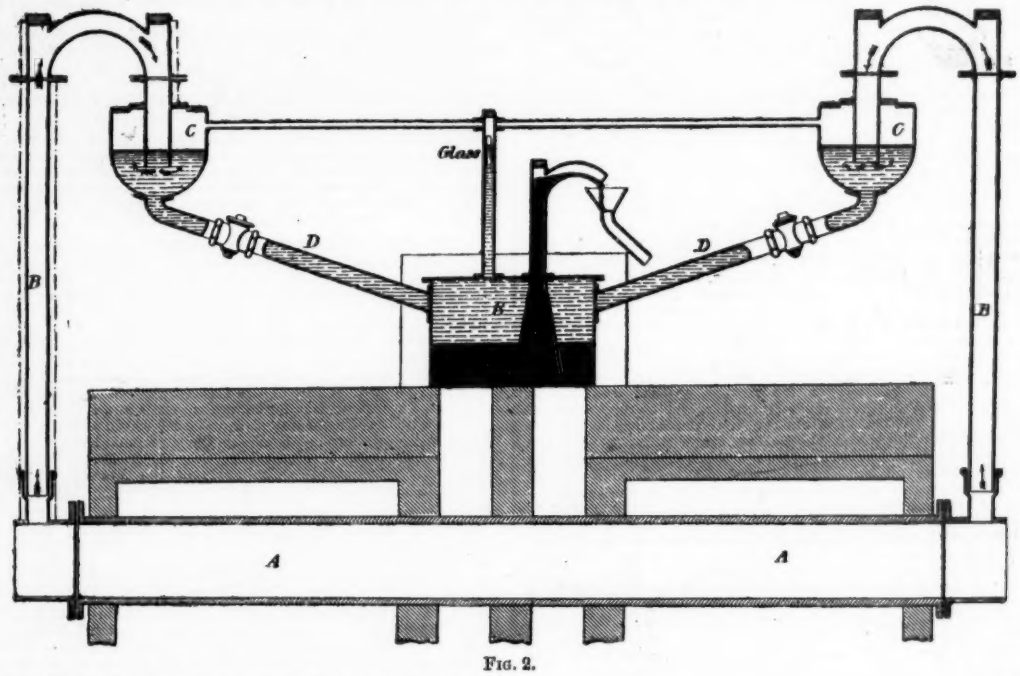

FIG. 2.

The drawing exhibits, in longitudinal section, one of a series of through retorts, A, fitted at its opposite ends with ascension-pipes, B, that lead to hydraulic mains, C, as commonly used in gas-works. These mains are connected by pipes, D D, with a vessel, E, into which the tar deposited by the gas in its passage through the hydraulic mains is discharged, instead of being allowed to accumulate, as at present, in the mains.

In connection with each of these hydraulic mains is an apparatus such as that shown in longitudinal sectional elevation in fig. 3, for subjecting the gas while in a heated state to the action of ammonia.

In this drawing, B represents the dip of one of the ascension-pipes, and C the end of the hydraulic main into which the hot gas from the retorts is conducted. F is an inclined chamber, divided by partitions, *f*, into compartments 1, 2, and 3, which compartments communicate with each other and with the hydraulic main by means of dip-pipes, *g*. These pipes are sealed by liquid ammonia, which is supplied thereto by a pipe, *h*, entering the compartment 3, the same being derived from the pumping apparatus described with reference to fig. 1. The compartments also connect with each other by openings in the partitions, *f*, near the floor of the chamber, and each compartment is fitted with an overflow-plate, *i*, which plates keep the liquor to the required level in the several compartments, and allow of the descent of the liquor as the supply is continued from the highest compartment to the lowest, and thence to the hydraulic main, from which it is discharged into any suitable receiver.

The gas, as it leaves the retorts, will retain its heat while passing up the pipes, B, by reason of such pipes being clothed with non-conducting material (such as is used for clothing steam-boilers), or otherwise protected from the cooling action of the atmosphere. The gas will thus enter the main at a temperature of some 200°, or in a condition best adapted for the efficient action of the ammonia thereon. It will then pass from the hydraulic main through the several compartments of the chamber, F, as indicated by the arrows, and in so doing it is caused to bubble through the ammoniacal liquor contained therein, leaving behind it the tarry products of the coal; the first discharge being, as before mentioned, into

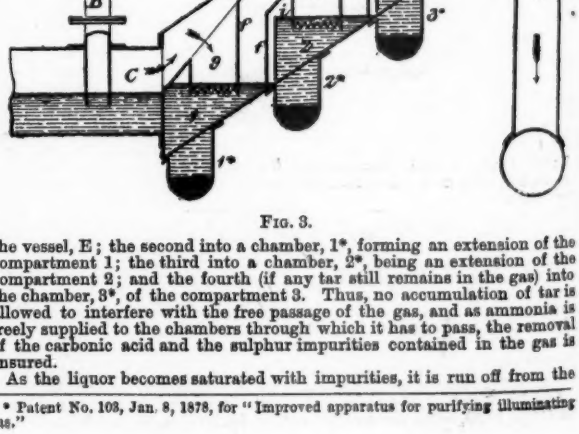

FIG. 3.

the vessel, E; the second into a chamber, 1*, forming an extension of the compartment 1; the third into a chamber, 2*, being an extension of the compartment 2; and the fourth (if any tar still remains in the gas) into the chamber, 3*, of the compartment 3. Thus, no accumulation of tar is allowed to interfere with the free passage of the gas, and as ammonia is freely supplied to the chambers through which it has to pass, the removal of the carbonic acid and the sulphur impurities contained in the gas is ensured.

As the liquor becomes saturated with impurities, it is run off from the

* Patent No. 3445, Sept. 12, 1877 (sealed Feb. 19, 1878), for "Improvements in the manufacture of coal gas, and in the treatment of ammoniacal liquor obtained in such manufacture."

* Patent No. 103, Jan. 8, 1878, for "Improved apparatus for purifying illuminating gas."

main, and is replaced by the downflow of purer liquor from the compartments of the chamber, F; a supply of pure liquid ammonia to that compartment being maintained during the process of purification. Connected with the compartment 3 of the chamber F is a pipe, G, which carries off the gas as it is purified, and conducts it to the scrubbers, where its temperature will be reduced, and it will be rendered fit to enter the gasholder. It may, however, be desirable to pass the gas through an oxide of iron purifier, in case the neutralization of the sulphur acids is not complete.

The patentees state that they have found, in carrying out the purification of gas according to this invention, that the gas derived from one ton of Newcastle coal will be thoroughly purified by passing the same while in a heated state through 120 gallons of ammoniacal liquor of the strength of 10 ounces of ammonia to the gallon. The gas, on leaving the chamber F, should not exceed a temperature of 100° Fahr.

For gas-works in which no hydraulic main is used, a modification of the above-described apparatus is employed, which is also adapted for the application of ammonia in the form of vapour, or it may be in the form of spray. This modification is shown in the annexed drawings, in which fig. 4 is a sectional elevation, and fig. 5 a plan of the same.

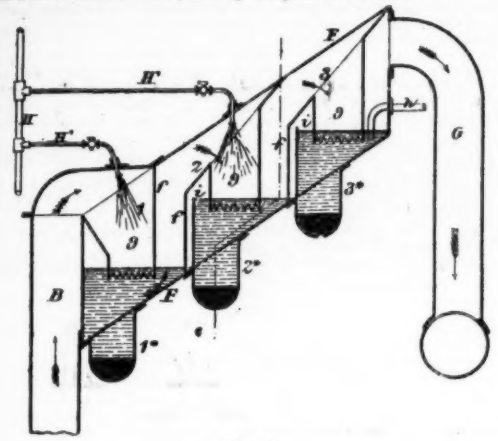

Fig. 4.

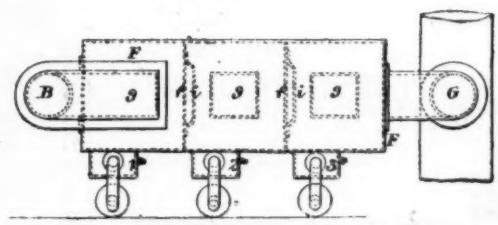

Fig. 5.

In this instance each ascension-pipe, B, is connected directly with the chamber F, which is in all respects, except in capacity breadthways, similar to that described with reference to fig. 3. A transverse section of this chamber is shown in fig. 6.

In this arrangement water is admitted by the pipe, *h*, and the ammonia is supplied from the pipes, H', which lead respectively into the compartments 1 and 2 of the chamber F. Thus the gas becomes commingled with the ammonia before passing into the liquor in the first compartment, and it is caused to yield up a large proportion of its impurities, after which its progress through the second and third compartment completes its purification.

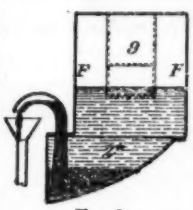

Fig. 6.

Although describing the above apparatus as that which, by preference, they employ, the patentees state that they do not limit themselves to the use of any particular apparatus for bringing the hot gas into contact with ammoniacal liquor for the purpose of purifying the same, as the only condition requisite is that there shall be an ample supply afforded to the gas to ensure the neutralizing of the acid compounds, and the absorption of the same into the liquor. For the purposes of the invention, the well-known Livesey washer, a diagram of which is shown at fig. 7, may be employed.

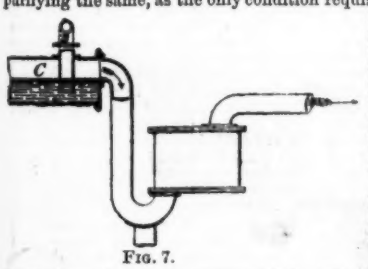

Fig. 7.

The patentees claim as the special feature of their invention—first, subjecting coal gas while in a heated state to the action of pure ammonia in the gaseous or liquid form, in the manner and for the purpose above described; secondly, obtaining pure ammonia from gas liquor in the manner above set forth.

LEEDS CORPORATION GAS-WORKS.

We learn from recent numbers of the Leeds newspapers that at a meeting of the Leeds Town Council on Monday, the 1st ult.—the Mayor (Alderman Carbutt) in the chair—a motion was submitted by Alderman Bower, Chairman of the Gas Committee, for an increase in the salary of Mr. H. Woodall, the Gas Engineer. This motion was brought forward with the concurrence, and on the recommendation, of the entire Committee except one member, who, curiously enough, had, at the meeting of the Committee, himself proposed a similar resolution. After a long discussion, the proposed increase was negatived by the Council, by a majority of three only in a Court at which 51 members were present. It further appears that at a general meeting of the Gas Committee, held on Thursday, the 25th ult., Mr. Woodall laid before them a statement, and it was resolved—"That the Engineer be authorized to send to each member of the Council a copy of the statement read by him on the work accomplished since his appointment."

We publish the document because it seems to us that few incidents could more forcibly illustrate the disadvantages under which corporation management of gas undertakings labour, than that it should be necessary to prepare such a statement. Mr. Woodall is to be congratulated that, under the provocation, he was able to present so eminently creditable an account of his stewardship.

The statement is as follows:—

Mr. Chairman and Gentlemen,—The failure which attended your kind attempt to secure for me, at the last meeting of the Town Council, the advance of salary which, as a large and most important Committee, you were almost unanimously of opinion I was deserving of, has induced in my mind a belief that the misfortune could only have resulted from want of information amongst those members of the Council not of the Gas Committee; and it is with a view of conveying to their minds some knowledge of the magnitude of the interests under your control, and of the responsible duties which fall to the share of your Engineer, that I ask you to allow me to submit the following brief summary of the work which has been accomplished since my appointment three years ago.

It will be in the recollection of most that, previously to my engagement, there was very general dissatisfaction throughout the town on account of the price, quality, and quantity of gas supplied; that the Gas Committee were unpopular, and that those who had promoted the purchase of the businesses from the Companies were charged with having made a disastrous bargain. It is further within my own experience that Counsel employed by Companies to oppose applications in Parliament by Towns Authorities desirous of securing possession of their undertakings, commonly used, as a strong argument on their side, the losses which had resulted from Corporate management of gas affairs in Leeds.

All this is now changed. There is an abundant supply of gas in every locality, the quality has been improved, and the price will shortly be as low as any in the kingdom. And, as a natural consequence, the good results achieved here are acting as a stimulus to Corporations to acquire similar privileges.

But it is not an uncommon impression, I believe, that this altered condition of affairs is attributable to the reduced value of coal. Permit me to show that this is by no means the case. The cost of coal, less coke sold, in 1875 was £61,559; in 1877 it was £50,732, or £10,827 less. Now, had the price of gas been the same in 1875 as in 1877, the loss on the former year would have been £14,010; whereas, in 1877, you showed a balance of profit of £8069, notwithstanding that you had expended on maintenance of plant, out of the revenue of that year, £15,578 in excess of the rate of expenditure in 1875. Summarized, the result is as follows:—

1875.	Loss as above	£14,010
1877.	Balance of profit	8,069
„	Extra expenditure	15,578
		£37,657
	Deduct difference on coal account	10,827
	Greater profit, apart from price of coal . . .	£26,830

The foregoing comparison is confined to the years 1875 and 1877. During 1878 the saving due to the lower market value of coal, as compared with that of 1877, did not exceed £4000. Yet the Committee were enabled to make another reduction in price of 6d. per 1000 feet, or £24,000 per annum to the town. And now again, from an estimate which I have prepared, and which will shortly come before you for consideration, it appears that in the coming year you will be in a position to make a further concession in price of 3d. per 1000 feet, or £12,000 per annum.

These three reductions (supposing the latter to be approved) all dating since June, 1876, are equal to a gain of £60,000 per annum. But, in addition, there has been an improvement in the quality of the gas worth about £5000, and there has been an increased rate of expenditure, on maintenance, of £10,000 a year, so that the gross saving effected is about £75,000. Deducting from this sum £15,000 as due to the reduced market value of coal, there remains £60,000 a year as gain consequent on improved management since 1875; an amount equal to the gross income from our magnificent water-works.

Now, I have no desire to lay claim unduly to these results as accruing from my management apart from the Committee, of whose conduct in relation to the business I have frequently expressed my admiration; but I am sure that the members of the Committee would not hesitate to assert that very much is due to the ability with which I have worked upon my practical experience of more than 20 years.

What is due to me personally is, perhaps, more apparent in what I have *not* done rather than by what has been accomplished. For instance, it is known to the Committee that shortly after arriving in Leeds I was informed that it was necessary for me to prepare plans for a new gasholder, in accordance with the recommendation of the late Engineer. I was, however, able at once to assert that such an expenditure as that work would involve was inexpedient; and, at a cost of about £200, I met the requirement, and have never felt the need of additional storeage to this day. A new gasholder would have cost about £15,000, and interest and maintenance at least £1000 per annum.

Economy in another direction is manifest in the construction of the new holder about to be erected in lieu of the one worn out in Dewsbury Road. For, if you double the present price of labour and material, to compensate for the greater cost at the date when the holder at Sheepscar was erected (an extreme estimate), there still remains a margin of £4 per 1000 cubic feet capacity in favour of the one recently contracted for; and, had similar economy been exercised in the construction of the Sheepscar holder, there would have been saved on that transaction alone not less than £5000. I venture to say that the same care has been given in every department of the diversified business under my management—a business which requires a capital of £1,000,000 sterling, which has an income of nearly £200,000, and the normal growth of which necessitates an expenditure on additional works of £20,000 a year.

I have thus briefly sketched out the gain which has resulted since my appointment. What has been my reward? A great increase in work, anxiety, and responsibility, and an absolute loss of £150 a year compared with the income I enjoyed in my previous situation! I came to Leeds proud of my appointment—than which there are not more than two or three so important in the provinces—confident of success, and equally confident that the sacrifice I was making at the time would shortly be recompensed. I need hardly say that the result of your appeal to the Council on my behalf was a disappointment to me; but I feel, nevertheless, that it is only necessary for Councillors to be informed as to the merits of the case to reverse their previous resolution, and to concede the very reasonable proposition submitted by a practically unanimous Committee, who, of themselves, are one-third of the Council.

At the risk of being considered tedious, may I say a word or two on the subject of leakage, which is often discussed in connection with our work?

The unaccounted-for gas in Leeds is now 15½ per cent. over 500 miles of

mains, about 80,000 service-pipes, and 60,000 meters. The length of mains, and other items enumerated, are greater, in proportion to the sale of gas, in Leeds than in any town that I am aware of in England. In Manchester and Birmingham, for instance, to about the same length of mains, and the same number of meters, there is fully double the consumption. Supposing, therefore, that all our customers were to double their consumption, it would not occasion the loss of an extra foot of gas to supply them; but the ratio of loss would be at once reduced to one-half of what it is at present, and would then be quite as low as obtains in either of the towns I have named. The subject is, however, receiving my earnest consideration, and I hope to be able to report considerable improvement on the coming year's working.

In conclusion, permit me to thank you Mr. Chairman, and the members of this Committee, for giving me such united and generous support at the last Council meeting. I assure you that I regarded your kindness as a very high compliment.

(Signed) HENRY WOODALL.

WATER GAS IN AMERICA.

Professor HENRY WURTZ, Ph.D., of New Jersey, has just presented to the President of the Municipal Gaslight Company, New York, the following report upon the Chemical Composition of the Gas manufactured at the Works of that Company:—

To Charles D. Francklund, Esq., President of the Municipal Gaslight Company, New York.

Sir,—Having been desired by you, in December last, to enter into a chemical investigation of the gas made at your works in 45th Street, I began such investigation about the 1st of January, and have been incessantly occupied therewith during the past two months.

As I stated to you in advance, your gas, in common with all others containing petroleum products, presents to the gas analyst certain difficulties which do not occur in the case of gas made from gas coal. These arise, as I then informed you, chiefly from the presence—long since maintained by me, in gas from petroleum—of a special series of hydrocarbon gases, generally believed not to exist in gas from coal, known as the "paraffin series"—*ethane*, *propane*, *butane*, and *pentane*. These hydrocarbons formed from petroleum, to which your gas, as I have since determined with precision, owes over one-fourth of its candle power, are not amenable to the absorbent action of sulphuric oxide, the agent employed for the "ethylene series," the illuminant hydrocarbons met with in ordinary coal gas analysis. With your gas it has therefore been necessary to try new processes, in the hope of solving this new problem. The processes I have devised and tested, though not as yet perfected, or as completely successful as I could wish, have nevertheless thrown valuable light upon the constitution of your complex gas, and have developed facts which I regard as of much interest, both to science and in practice.

A laboratory was fitted up by me at your works, adapted for ordinary eudiometry as well as for my own peculiar class of methods (published three years since), called by me *Train Analysis*, or Gravimetric Analysis of Gaseous Currents; the only methods as yet discovered by which any success could be hoped for in work of this kind. In these new methods large volumes of gas are operated on, many hundreds or thousands of cubic inches, or even many cubic feet, instead of only a fraction of one cubic inch as in eudiometry. The gas is measured before and after absorption of its constituents, by means of carefully regulated and corrected gas-meters, with far greater proportional accuracy than is practicable in a eudiometer. Moreover, in addition to the determinations by volume, the absorbents are contained in pieces of apparatus *weighed* before and after the absorption, so that the *weights* of the different constituents are likewise ascertained. The additional device was introduced into this research, of numerous and careful *density determinations* of the gas by the effusion method of Bunsen, before and after the action of the absorbents and passage through the meters, by which a new and valuable control is obtained of the direct determinations of volumes of constituents by the meters, as well as a knowledge sometimes otherwise unattainable, of the densities, in gaseous or vaporous form, of several important constituents.

Previous to the present research, I have made no successful application of this mode of gravimetric train-analysis to the determination of *illuminant hydrocarbons*; but I now find it in the highest degree valuable for this purpose, particularly with regard to the olefines. Trains were fitted up, in which the gas was first measured through a meter charged with glycerine, whose rate had been accurately ascertained, then passed, generally at the rate of about one cubic foot each two hours, through proper solid reagents in granulated forms, to remove traces of carbonic acid, sulphur, ammonia, and water, and then through a tube containing broken pumice, saturated with fuming sulphuric acid, which was weighed (together with a succeeding tube containing solid caustic soda to retain the volatile acid products formed), the gain in weight, together with the loss of volume, as found by subsequent passage through a similar meter, giving us both the volume and the weight of the olefines, with any naphthaline, acetylene, and benzole that may be present. Determinations of the *density* of the gas, before and after passage through this train—making due allowance for the minute impurities and moisture present—give other data for calculating both the weight and density of the olefines, &c. The gas thus deprived of olefines passes from the meter at the tail of the train into a small gasholder constructed for the purpose, whence it can be taken for photometric, densimetric, or eudiometric experiments, or for passage through further trains. The results thus obtained with your gas of different dates may be stated as follows:—

Feb. 5.—On this day the first important analytical results were obtained, after spending some weeks in fitting up and testing apparatus and methods. The gas from the street-main was found to have a density of ·7011, and a candle power of 24·48. On passing through such a weighed train as described above, for absorbing the olefines (with benzole and its homologues, acetylene and naphthaline*), by means of the ordinary solution of sulphuric oxide in oil of vitriol ("fuming sulphuric acid"), the absorption by volume was found, by two experiments, each made upon 1·5 cubic foot of gas, to be 8·74 and 8·86 per cent.; the mean being 8·8 per cent. The gain in weight of the sulphuric oxide tubes (of which, for certainty, three were used in the train—the absorption, and consequent deep brown coloration, and evolution of heat, appearing in the first one only) was at the rate of 71·1 grains per cubic foot; the whole increase of weight of the train, including aqueous vapour, &c., being 79·36 grains per cubic foot. The residual gas, which still *burned with a flame of considerable brightness*, having been passed into the holder, was then conducted into the adjoining photometric room through glass tubes, and its candle power carefully determined to be 6·59. This residual candle power must, of course, be attributed to the class of hydrocarbon gases I have referred to above, the paraffin homologues, which, under these circumstances, are not absorbed by sulphuric oxide. To make doubly sure of this remarkable result, this sample of gas was again passed from the holder through the two meters, with a fresh train intervening, made up of two freshly-charged sulphuric oxide tubes and their attachments. The two meters now moved together exactly, revolution after revolution, till the holder was empty; no absorption or coloration of the pumice appearing, and the gas burning at the tail of the train with the same luminosity as before. This first series of experiments having proved the accuracy of my anticipation, and the fact that a large proportion of the paraffin homologues exist in your gas, the investigation proceeded at once with all possible diligence.

Feb. 7.—New trains having been prepared, the former experiments were repeated with still more care. The gas from the street-main, with a density of ·7032 (mean of three determinations), gave an absorption of olefines, &c., per cubic foot = 77·05 grains. The volume of these hydrocarbons, by five successive experiments, upon 864 cubic inches each, was 9·7, 9·8, 9·25, 9·86, and 8·9; mean = 9·5 per cent. of the gas. This residual gas possessed apparently somewhat more candle power than in the previous case; and again, on passing through a fresh train, was not in any way changed in volume or otherwise.

Feb. 13.—New and powerful trains, and other extensive arrangements, having been completed on this day, an elaborate series of experiments, including eudiometry, densimetry, and photometry, were begun upon the gas of this date. The density determinations of the gas from the street-main were three in number:—

·6806
·6848
·6869

Mean, ·6844

The total condensation in the train was 75·96 grains per cubic foot, including 74·19 grains of olefines, &c.; the volume of these latter being—as the mean shrinkage of a very large volume of the gas passed for the whole day through the train—9·29 per cent. The candle power was 24·32. It may as well be here stated that other photometric determinations were subsequently made by me, all with great care and precision, none of which have given me a result below 24 candles.

After absorption of the olefines, the density of the residual gas was—

·5929
·5968
·6006

Mean, ·5968

Computation here proves that 1000 cubic feet of your street gas, at 60° Fahr., weighs 364,800 grains, or 52·11 lbs. avoirdupois, and contains 74,190 grains, or 10·6 lbs. of olefine hydrocarbons. The mean density of the latter constituents is found from these figures to be 1·5, which is somewhat higher than that of propylene (= 1·455), as well as of a mixture in equal proportions of—what are doubtless its chief ingredients—

Ethylene (Olefiant gas), density	=	·968
Propylene	=	1·455
Butylene	=	1·940
Mean		1·454

Four per cent. of *benzole vapour* (density = 2·7) in such a mixture would bring its density up to about that which was found. The above figure for the mean density of the olefine hydrocarbons (= 1·5) is computed from the loss of volume as shown by the meters, with the actual increase of weight of the tubes in the train. It is readily controlled—and the precision of this new system of gas analysis conclusively demonstrated—by computing it in another way, from the loss of volume, with the *densities* of the gas before and after passing the train. Thus:—The 90·71 cubic feet remaining after absorption of 9·29 per cent. of olefines from 100 feet, weighs by its density as found = ·5968 × 533 × 90·71 = 28,855 grains (one cubic foot of air at 60° Fahr. = 533 grains). This, together with 175 grains of moisture, &c., also condensed, being deducted from 36,480 grains (the weight of 100 feet of the street gas computed from its density), leaves for the weight of the 9·29 volumes per cent. of olefines 7450 grains; whence we get again the density = 1·505. [It may be remarked that the densities of the olefine gases, as computed from the analyses of Feb. 5 and 7, were then a little higher—1·516 and 1·521.]

The Paraffins.—On this day, Feb. 13, experiments were begun, and continued for many days, with great labour, with the object of separating the gaseous paraffin homologues, proved as above to be largely present in this gas, by the action of *bromine* upon the residual gas, after it has passed the tubes containing sulphuric oxide. It is well known that marsh gas is not at all acted upon by bromine, unless in sunlight; but it is equally well recognized that all the other members of this homologous series are violently attacked, even in the dark, by this potent agent. Schorlemmer, Thorpe, and Young, and other chemists have described many of the products of these paraffin brominations. There appears a tendency to form dibrominated compounds of very high boiling-points. For example, the hydrocarbon *pentane*, $C_5 H_{12}$, whose boiling point is about 86° Fahr. (and which is no doubt contained, as vapour, in your gas), forms the product $C_5 H_{10} Br_2$, whose boiling-point is as high as 367° Fahr.; and *butane* $C_4 H_{10}$, which boils at the freezing-point of water, would form $C_4 H_8 Br_2$, the boiling-point of which would be about 345° Fahr. The latter is as yet unexamined. On the assumption that this bromination would be a simple matter of substitution of bromine for hydrogen, the only *gaseous* product being hydrobromic acid, trains were fitted up with flasks of liquid bromine, and provided with tubes of granulated pumice soaked in caustic soda, to absorb the gaseous acid, together with the excess of bromine vapour. These were kept from the light during action. On Feb. 13, such a train yielded, in a series of experiments on 173 cubic inches each, the following absorptions, per cent.:—5·1; 5·15; 5·2; 5·02; 5·03; 5·25. On a subsequent day, a similar train gave a series of closely agreeing figures, averaging 5·65 per cent. of the street gas.* Before deciding upon the value of this method, however, it was necessary to make analyses of the residual gas after passing the bromine train. Such analyses (which, to save space, will not be quoted here) showed that there was during the reaction a large production of *marsh gas*, this being verified also by the fact that the density of the gas underwent very little decrease during the reaction. In the last case above, gas freed from olefines, of density ·632 was reduced by bromine to ·599 only. One conclusion to be drawn from these facts is this—that as no marsh gas can be evolved from any of its homologues, without expansion of volume, hence the condensation of 5 to 5·5 per cent., shown above, is necessarily *less* than the volume of paraffin gases condensed by the bromine, and thus this method may at least be regarded as indicating a minimum proportion of these hydrocarbons. It will be shown below that the denser paraffins cannot well be admitted to exist in your gas in a less proportion than 7 or 8 per cent.

The Water Gas.—It was found impracticable to arrive at a full comprehension of the constitution of your gas, without most careful analyses and density determinations of the water gas, which forms its main constituent, by volume. Feb. 13 was one of the days on which samples were secured of the water gas for eudiometry, and on which sets of most careful density

* The amounts of acetylene and naphthaline in this gas were found to be very trifling. That of benzole was more appreciable.

* The quantity of bromine taken up was something quite surprising, being, in the neighbourhood of an ounce for each cubic foot of gas previously freed from olefines.

determinations were made, at intervals, during the time of running of the analytical trains. The mean densities were as follows:—

1	·4900
2	·4900
3	·4935
Mean of all	·4912

Eudiometry by explosion gave as follows:—

			Multiplied by the densities × ·01.		
Hydrogen	49·32	×	·000693	=	·0342
Marsh gas	7·65	×	·00553	=	·0423
Carbonic oxide	37·97	×	·009674	=	·3673
Carbonic acid	·14	×	·0152	=	·0021
Nitrogen	4·79	×	·0097	=	·0465
Oxygen	·13	×	·01106	=	·0014
	100·00		Computed density =		·4938

The densities here used for the several gases are those adopted by Bunsen. Determinations of carbonic oxide, made by absorption with chloride of copper, gave, as a mean, 38·46 per cent. The closeness of correspondence of the densities, by computation and experiment, leave no doubt of the correctness of the above tabulated composition.

The Illuminating Gas.—Attempts to obtain, by direct determination, a precise knowledge of the composition of your completed illuminating gas, were found even more troublesome than had been anticipated. It was supposed that no difficulty would occur, for example, in direct determination of the carbonic oxide by chloride of copper, after passage through the train which abstracted the olefines. It was found, however, that the determinations thus made were too large, and included evidently a portion at least of the heavy paraffin hydrocarbons. It was even found that these denser paraffins were partly absorbed by fuming sulphuric acid, when introduced in liquid form into the eudiometer-tube over mercury; to account for which I can at present offer only the hypothesis that the *sulphurous oxide*, always largely produced by the action of the fuming acid on the mercury, has the power of combining with and liquefying some of the denser paraffins. It was only when the fuming acid was used after Bunsen's mode, as absorbed into a porous pellet or rod, without contact with the mercury, that results were obtained corresponding to those in the analytical train. Complex and roundabout methods were used, but none gave such satisfactory and consistent results as those which were founded partly upon careful determinations of the *densities* of the original gas and of the residue after absorption of the olefines. The first statement below is founded as much as possible upon direct determinations; the *olefines* and *carbonic acid* from volume and weight in meter and train, the *carbonic oxide* by direct absorption with chloride of copper after repeated treatment with liquid fuming acid in the eudiometer, the *hydrogen* and *marsh gas* by explosion of the residue from the chloride of copper, and the *paraffins* representing the minimum absorption in the bromine train.

			Densities × ·01		
Hydogen	38·20	×	·000693	=	·0265
Marsh gas	15·82	×	·00553	=	·0875
Carbonic oxide	27·14	×	·009674	=	·2626
Carbonic acid	·10	×	·0152	=	·0015
Oxygen	·10	×	·011	=	·0011
Nitrogen	3·35	×	·0097	=	·0325
Olefines	9·29	×	·015	=	·1394
Paraffins (higher than CH_4)	6·00	×	·0222	=	·1333
Computed density				=	·6844

It is to be explained that the computed density here, ·6844, the same as found by experiment for the gas, is arrived at by assuming the density 2·22 as that of the minimum volume admissible for the paraffins. The computation is, therefore, to be regarded as a determination of the maximum density possible for the paraffins. With the assumption for the latter of a larger volume, diminishing the marsh gas proportionally, their density will fall below the incredibly large figure, 2·22. The paraffins which, doubtless, make up the bulk of those present are—

		Densities.
Ethane	C_2H_6	1·04
Propane	C_3H_8	1·522
Butane	C_4H_{10}	2·0

The next one, pentane (C_5H_{12}), has the boiling-point 86° Fahr., only 10° below that of ether, and ought, therefore, to be present in comparatively small proportion.

The next table given presents what I believe to be a much closer computation of the composition of your gas, of the date Feb. 13. Those constituents whose proportions differ from the above, were arrived at as follows:—Your Engineer stated to me the net amount of naphtha introduced into your gas per 1000 feet, as *four gallons*. A sample of this naphtha, obtained from him, had a density of ·694 (water = 1). The four gallons weigh, therefore, 161,920 grains.

100 cub. feet of gas, of density ·6844, weigh	36,480 grains.
Deducting 0·4 gallon of naphtha =	16,192 ,,
We have the weight of the water gas in 100 cubic feet =	20,288 grains.
By the density of the water gas = ·4912, its volume computes to	77·44 cub. feet in 100.
Adding the known volume of the olefines =	9·29 ,, ,,
The sum is =	86·73 cub. feet in 100.

And deducting from 100, we get the sum of all the paraffin homologues (including the marsh gas), derived from the naptha = 13·27 cubic feet in 100.

If now for the denser paraffin homologues (called, for simplicity, "paraffins)" we assume a figure which gives them a density much more within bounds = 7·5, we get for the marsh gas derived from the naphtha, which is to be added to that contained in the water gas = 5·77 cubic feet. These data give us, for the total composition—

			Density × ·01		
Hydrogen	38·05	×	·000693	=	·0264
Marsh gas	11·85	×	·00553	=	·0655
Carbonic oxide	29·40	×	·009674	=	·2844
Carbonic acid	·10	×	·0152	=	·0015
Oxygen	·10	×	·011	=	·0011
Nitrogen	3·71	×	·0097	=	·0360
Olefines	9·29	×	·015	=	·1394
Paraffins	7·50	×	·01735	=	·1301
					·6844

Giving for the density of the denser paraffins = 1·735; a figure which even yet seems higher than can be admitted as probable, but which can only be reduced, in accordance with the fixed data of the problem, by increasing the proportion of the denser paraffins, an increase which must necessarily be deducted from the marsh gas, falling upon that only.

In further prosecution of eudiometric and other work, further analytical results were copiously obtained, up nearly to the close of the month of February; insomuch that time has not yet permitted the computation of a number of the analyses made. They were all generally confirmatory of the above conclusions, and hence it is not deemed necessary to swell this report with many additional figures. I shall therefore cite here only one more result; an analysis of the water gas of date Feb. 27, which differs quite considerably in some respects from the water gas analysis previously given, and may have been the product of a lower heat in the generators:—

Hydrogen	55·14	×	·000693	=	·038
Marsh gas	3·04	×	·00553	=	·017
Carbonic oxide	35·35	×	·009674	=	·342
Carbonic acid	·18	×	·0152	=	·059
Nitrogen	6·08	×	·0097	=	·002
Oxygen	·21	×	·01106	=	·003
Computed density				=	·461

The density figures, as obtained by experiment on this day, were ·461, ·459, ·450, ·453, ·453, ·457, ·453, and ·455; the mean of these eight being = ·455. This is a little lower than the computed density, which may possibly be due to a slight over-estimation of the *nitrogen* in the analysis. One per cent. less of nitrogen brings the computed density quite down to that found by effusion.

Analysis of Municipal Gas by Others.

My attention was called by you to certain figures published in the *American Gaslight Journal*, at the time my own analyses were in progress, which claim to represent the composition of the gas served out to consumers by the Municipal Gas Light Company. As these figures are in almost every respect obviously irreconciliable with my own, it is certainly incumbent on me to present the reasons which I readily recognize for pronouncing them inadmissible.

These figures are as follows:—

Hydrogen	24·89
Marsh gas	25·99
Carbonic oxide	27·34
Carbonic acid	·33
Oxygen	·56
Nitrogen	4·57
Olefines	16·32
	100·00

One important criterion which I have indicated in this report cannot be applied by me at present to these figures, namely that of a comparison of the *density*, as determined by experiment, with that computed from the figures; the authors having failed to state the density. Nor do they mention the date of their sample of gas, which would have enabled me to ascertain the density from the record kept at your works.

There is, however, another criterion which I find to be conclusively applicable to this case, and which shows at once that some fatal fallacies must have pervaded the methods by which these figures were arrived at. It may be laid down as a rule regarding all gases made like yours—a rule which, when once stated, will be conceded as obvious by those who possess but rudimentary chemical knowledge—which is, that *the total oxygen-volume represented in the products cannot exceed half the total volume of the free hydrogen.* That is, the oxygen cannot be in excess over the proportion contained in water, which is the source of all the oxygen except accidental traces. In point of fact, the conditions of the case compel that the free hydrogen in such a gas shall be quite largely in excess of the oxygen represented in all forms, or much *more than double* the volume of the latter. This is because a large proportion of the oxygen proceeding from the steam is converted into *carbonic acid*, and being abstracted by the water in the washers, and by the lime in the purifiers, cannot appear, in any form, in the gas. It also requires a very appreciable amount of the oxygen of the steam to oxidize the *iron* (and partially the *sulphur*) of *pyrites* in the coal, another reason for a necessary deficiency of this element. It seems quite probable that some further proportion of free hydrogen may also arise from decomposition of the naphtha in your retorts; but this latter *may* be only matter of supposition. The former reasons for an excess of hydrogen, however, are absolute, and cogent beyond all dispute.

If now we add together the oxygen shown in the above figures (from the *American Gaslight Journal*), we obtain:—

For the carbonic oxide, half its volume =	13·67
For the carbonic acid, its own volume =	·33
For the free oxygen =	·56
In all =	14·56

While half the hydrogen volume present is but 12.45.

This chemical impossibility being encountered on the threshold, I feel compelled to submit that further critical examination of these figures would be waste of time and space. Otherwise, a discussion of the methods used would develop at least some reasons for regarding the results with great reserve. It must suffice to mention that these authors believe that the paraffin or marsh gas homologues are all *unattacked by bromine.*

Remarks upon the Composition of the Gas.

It is first to be observed that my analyses fully confirm the fact of the existence in your gas of one-fourth at least of *carbonic oxide*, a constituent which has been of late pronounced in certain quarters to render your gas *dangerous* as an illuminating agent in households, by reason of a putative *poisoning of the air* of rooms supplied with it. In a preliminary letter on this subject, addressed to you, I have already pronounced this an imaginary danger. Your gas has a very marked odour, even more so than that from gas coal; and no leak or emission could occur, sufficient to produce a dangerous impregnation of a confined atmosphere, without alarming the sense of smell—in cases of persons possessed thereof—to an intolerable degree. It is a familiar circumstance, contingent upon the use of *all* illuminating gases, that accidents will happen, especially to *sleeping* persons. Your gas will not increase such dangers, which can only be averted by reasonable care. The record clearly supports the assertion that even *pure carbonic oxide* is little, if any, more poisonous to animals than ordinary gas from gas coal. Illuminating gases have for many years been largely in use, in many parts of the civilized world, made from *wood*, *peat*, *lignites*, *rosin*, *fatty oils*, *bark*, and *cork*; all of which are highly oxidized substances, and often produce gases containing much more carbonic oxide than yours. Yet neither fact nor fancy ever supported an accusation against these as being "extra-hazardous" to health or life. Wood gas, for example, which is quite a common manufacture, contains sometimes more than 40 per cent. of carbonic oxide; and peat gases often contain nearly as much. From this point of view, the harping upon this accusation, of a new and terribly deadly agent being palmed upon the public, suggests such a partizan *animus* as might arise from "conflicting interests" endangered. No accumulation of citations of vague and crude *opinions*, stereotyped through generations of school-books, as to the danger of small per centages of carbonic oxide in air, should have any influence on reasonable minds, when it

is only by rare accident or stupidity that even these small per centages can be communicated to the air of a close room. To impart to the air of a small bed-room, of 1500 cubic feet capacity, if it should happen to be hermetically closed, the one per cent. which is stated by some to be fatal to *small animals* (though statements conflict much on this head), would require that a burner emitting 4 feet per hour of your heavy gas—which would be a *5-foot burner* for common coal gas—should remain wide open for some 13 *hours*; much longer than any ordinary night's sleep. And proof remains to be produced that 1 per cent. of carbonic oxide will poison, narcotize, or even permanently injure, a human subject, while there is plenty of evidence that such a 5-foot burner, emitting *coal gas* in such a room, will produce, and has produced insensibility, and even led to the death, of occupants thereof.

There is to this question, however, another important aspect, which has not as yet received any adequate attention; but an aspect which is brought up to me strongly by the figures of my analyses. *Occasional* injuries and dangers arise, from leaks of mains and gas-pipes, with any gas; but there is another circumstance *constantly* arising from ordinary gas illumination, which is not occasional, but perpetual and unavoidable. This is the contamination, or rather *devitalization* of the air of close rooms by gradual abstraction of its oxygen. It is now well understood that the balance of normal oxygen absorption by the human blood is so delicate that very serious disturbances arise from quite minute variations in this respect—such, for example, as follow upon the slight variations of tension accompanying barometric changes. Many gas-burners in a confined space, in time, produce an effect on the air which even persons of the strongest nerves and circulations cannot defy. This is an ever-recurrent cause of debility, and a nightly morbific influence, to which multitudes are incessantly exposed. Anything which will mitigate this unavoidable evil should commend itself to public attention. I have already indicated to you, in a previous communication, that of the two constituents of an illuminating gas—marsh gas and carbonic oxide—the latter is far preferable, in regard to this highly important matter of air consumption. Marsh gas requires for combustion, indeed, *four times as much oxygen* as carbonic oxide, the latter being in this respect on a par with hydrogen. My analyses indicate, in your gas, a proportion of marsh gas so much lower than has heretofore been supposed, that I feel justified in claiming this as a development that has well rewarded the time and labour expended.

One further point, that should tell to the advantage of your gas, with the (unprejudiced) public, is that by reason of the greater density and consequently slower diffusion of your gas, *explosive mixtures* will be much longer in forming, through leaks; and dangers of this sort must needs be lessened. As between carbonic oxide and marsh gas, again, explosions of the latter, *ceteris paribus*, are far more violent than of the former, for the reason that marsh gas contains four volumes of hydrogen condensed into one. Marsh gas is the terrible "fire-damp" of coal-mines, whose explosions have destroyed so much human life. It will, I presume, be conceded, as a matter of fact, that dangers, losses, and fatalities from *gas explosions* are beyond all comparison more serious than cases of suffocation. This new suggestion will thus be seen to have great practical weight.

Conclusions.

I would sum up my two months incessant and laborious study of the chemistry of your gas as follows:—

1. The Municipal Gaslight Company are serving out to consumers a gas of uniform quality, which compares in brilliancy, whiteness, and other qualities of light with the finest cannel gas, while destitute of any fuliginous or smoky properties, as well as of any liability to condense by ordinary cold; its illuminating power for 5 feet per hour, measured by one of the test-meters of the American Meter Company, being uniformly up to *twenty-four candles* during my experiments.

2. This gas, in the case of equal leakage, will not be more dangerous to health than gas from gas coal; and, by reason of its higher density and less liability, therefore, to leakage under equal pressures, it will, I believe, be less dangerous in this way than gas from coal.

3. By reason of the greater density of this gas, its diffusive tendency through air is less, and it will hence be slower than coal gas in forming explosive mixtures with air, even in case of equal leakage.

4. On account of its far smaller proportion of marsh gas, the violence of the explosions of equal volumes with air will be much less, and the introduction of your gas will therefore reduce risks both to life and property.

Hoboken, March 4, 1878. HENRY WURTZ.

LIGHTING BY ELECTRICITY.

[Translated from the *Journal des Usines à Gaz.*]

We give to-day, from the *Bulletin de l'Association Scientifique de France*, a *résumé* of the lecture delivered at the Sorbonne, on the 9th of February last, on the subject of the Electric Light, by M. Jamin, Member of the Institute, and Professor at the Polytechnic School and at the Faculty of Sciences, adding, at its conclusion, a few observations of our own. We shall not speak of the formation of the *Compagnie Parisienne d'Eclairage par l'Electricité*, as the controversy on this subject would fill our columns. It is, however, interesting in more than one respect, and we strongly advise gas shareholders to make themselves acquainted with it through the medium of the financial papers. We have no doubt whatever that they will keep their money in their pockets.

M. Jamin's lecture was as follows:—

Forty years after the discovery made by Volta about the year 1813, one of the most illustrious of English chemists, Humphry Davy, performed a memorable experiment. He took two red-hot carbons, which he extinguished in mercury, pointed them, and, having fixed them to the *rhéophores* of a pile, placed them in contact. The points became heated to a red heat; he then drew them apart, and saw produced between them a slightly convex flame, which he called the *electric arc*. It possessed a brilliancy comparable to that of the sun, and its temperature was so high that platinum melted in it like wax. This arc could be produced in a vacuum as well as in the air, its size could be increased to 10 centimètres (4 inches) by drawing back the conductors, after which it went out, and could not be re-lighted except by again putting the carbons in contact.

This magnificent experiment necessitated a very large pile; besides, Davy not thinking of making it the principle of a new system of lighting, this idea was not conceived and realized until considerable progress had been made in the art of producing electricity. Sufficient advancement has been made, however, by this time to allow the electric lamp to take, in point of economy, the first place in lighting on a large scale. The hall in which we are assembled is illuminated by 14 electric focuses, equal altogether to 1400 Carcel burners. I venture to assert, and you will not contradict me, that never was there illumination more beautiful, more inoffensive, more agreeable to the eyes, and more favourable for colours. It is supplied to us gratuitously by two Companies—that of MM. Denayrouze and Jablochkoff, and that of M. Lontin, rivals before the public, and rivals also in the eagerness they have displayed to appear before us. Let me first of all, in my own name as well as in yours, offer them our thanks; I shall afterwards explain in a few words the processes employed for developing the new light, and make a systematic analysis of its good qualities and its defects.

It is no longer Volta's pile that provides us with the current; we obtain it from machines based upon induction. The illustrious Faraday discovered that a coil of isolated copper wires, rolled upon soft iron, becomes the seat of a current of induction, very short, but very intense, when it is brought near the poles of a magnet, and that another current, inverse to the first, and like it instantaneous, yet more intense, is afterwards developed if the coil is suddenly drawn away. Very soon after this discovery was made, Pixii and Clarke invented the first electro-motors. Clarke's apparatus consisted of an electro-magnet which turned rapidly before the poles of a magnet, and was traversed at each revolution by two induction currents from contrary directions, sufficiently strong to cause very great commotion. It was only necessary to multiply the coils, enlarge them, and increase the power of the magnets, in order to obtain the electric light. This is what was done successively by several inventors, among whom may be specially cited Nollet, Gramme, and Lontin. [The Professor here briefly explained the principal known magneto-electric machines.]

It was not sufficient to have constructed magneto-electric machines; it was still necessary to regulate the light of the arc. In fact, the carbons consume away very rapidly, not only because they burn in the open air, but because the material of which they are composed is carried away by the current, and shifts from one point to another. An apparatus called a "regulator" was thereupon contrived. It consists of a very delicate mechanism, by means of which the carbons, though being continually brought near to each other by a spring arrangement, are at the same time held back by a lever attracted by an electro-magnet. If the current diminishes or ceases altogether by the separation of the carbons, the spring brings them closer together again; if, on the contrary, it increases by the contact of the carbons, the lever draws them away to a distance which remains nearly constant.

This problem of the regulation of the currents was felt to be of such importance that a legion of inventors sought for and found its mechanical solution. There are, therefore, a large number of regulators in existence, the productions of Duboscq, Foucault, Serrin, Gramme, Carré, Lontin, and others. M. Serrin's regulator is the one most generally employed.

Notwithstanding all the care bestowed upon their construction, regulators still leave something to be desired, inasmuch as their action is not continuous. The carbons remain at rest up to the moment when the distance between them attains a determined limit, after which the mechanism brings them suddenly together again, thus causing a more or less sensible alteration of the light, which, occurring at frequent intervals, very seriously interferes with its steadiness, and constitutes what has up to the present time been the greatest obstacle to the employment of electricity.

While mechanicians were looking for this regulator, a young Russian officer, M. Jablochkoff, discovered the means of dispensing with it altogether. Having been kindly admitted into the studio of M. Bréguet, he invented the "candle" which bears his name. Let us imagine two cylindrical parallel carbons, placed vertically, separated by a plate of gypsum, and simply connected at the top by two points. When the current is made to pass from one to the other, the arc is seen to burn at the upper extremity, and descend little by little as the carbons are consumed. It then reaches the top of the gypsum plate, which melts, disappears in smoke, and the destruction of the carbons taking place simultaneously with that of the gypsum, the candle burns slowly and steadily from top to bottom. The simplicity and perfect regularity of this new system, which has at one blow got rid of the unsteadiness of the light, will be readily understood.

We will now turn our attention to the arc, and the best way of studying it is to throw its image on to a white screen. It is not very clear, because it is enlarged, and on account of the light being diffused in all directions, rendering the image visible from all parts of the hall. We see that the carbons become very brilliant, that they are perfectly white, that the positive is more luminous than the negative, that the former diminishes while the latter increases, thus indicating a transference of the carbonaceous matter in the direction of the current. The space left between these two carbons is occupied by a flame much less intense, of a violet tint, animated by a tumultuous transporting movement, and traversed from time to time by sparks of matter carried away by the current. There is no doubt that the current is carried over by the carbonaceous matter itself, spread out in vapour between the two conductors. It is these carbons and this arc, in their entirety, that emit the electric light, the properties of which we are about to study.

First of all we must measure its lighting capacity. It is said that two lights are equal in quantity when, placed at the same distance, they give an equal amount of illumination. If, in order to be equal to the first, we have to withdraw the second to double the distance, thus reducing its illuminating power to one-fourth, we conclude that at an equal distance this second light would give four times the amount of illumination. And so we have the general rule that the quantities of two lights are in direct ratio to the distances at which they have to be placed to obtain equal luminosity, and the measure is taken by means of photometers, a description of which need not here be given. It has been agreed to compare the various quantities of light with that of a Carcel lamp burning white, and consuming 40 grammes of colza oil per hour. We shall, therefore, say that a light is equal to 10, 15, or 100 Carcel burners, in order to express that it sends the same amount of luminosity to the same distance as 10, 15, or 100 lamps of the type chosen, and with which we are going to compare the electric light.

Of all the tests of the illuminating value of the light, I shall take that of which the accuracy will be the least contested—one conducted with every precaution by a master of the application of mechanics, M. Tresca. He found that the light furnished by a Gramme machine was equivalent to 1850 Carcel burners. This number is enormous, and its enormity surpasses the proportions our minds are in the habit of comparing. A more exact notion would be conveyed by saying that in order to obtain the same amount of light it would be necessary to burn in one hour 78 kilogrammes (172 lbs.) of oil, or the bulk of gas contained in a balloon 9 mètres (30 feet) in diameter. Now, it is this enormous amount of light that we obtain from an electric focus. It is said that it is not necessary, that it exceeds our wants, and that, being indivisible, it will be rather a trouble to us than a benefit. This is an error, for it *is* divisible. First of all, it was divided by M. Leroux. Then smaller machines were employed, which reduced the regulator to 75 burners. Finally, M. Jablochkoff is able to place in the same circuit a very large number of candles, among which the light is divided, each being equal to 50 gas-burners. He can place 37 candles upon the current above cited, and by the aid of the following artifice has gone still farther. He prepares some condensers of very large surface, with sheets of tin separated by layers of silk, and then connects the two armatures with the extremities of a machine giving alternate currents. It is evident that the electricity of each current is first of all condensed and then replaced by the contrary electricity of the opposite current, the result being a modification of the composition of the currents furnished. What that modification is, is a point which merits attention

that it has not received. However, it is always the case that by breaking the circuit at a certain point, sparks surrounded by a very pale yellow flame are given off, the whole being accompanied by a peculiar rumbling sound, constituting one of the most beautiful experiments in electricity.

So much for science; now for its application. If a current is capable of lighting four candles of 50 burners, the same current, when acted upon by the condensers, can supply double the number—namely, eight candles, each one equal, not to 25 burners, but to rather more. We must not seek to push the division farther. The new light must progress; it must not simply replace one Carcel lamp, but must surpass it. The light could, however, be still further subdivided by lighting some rods of carbon, or, as M. Jablochkoff does, a thin plate of kaolin. [These experiments were described in detail.]

It is not solely on the score of quantity that the light of the arc is superior to all the other lighting focuses, but also for its brilliancy. Given two luminaries of the same extent, affording the same amount of light of the same brilliancy, if one furnishes twice, three times, or four times as much light with an equal extent, there is a brilliancy equal to twice, three times, or four times that of the other. Brilliancy may, therefore, be thus defined: The total amount of light conveyed by the unit of surface to the unit of distance, and the light of the Carcel burner may be taken as unity. Now, according to a learned treatise published by M. Allard, Engineer of Lighthouses, we find that the brilliancy of the arc is at least 600 times as great as that of the flame of a Carcel burner. The eye readily appreciates this difference. In fixing the value of the electric light, he saw it surrounded by divergent rays forming a kind of halo, and could find no other term of comparison than the sun. M. Fizeau, in fact, compared it to the sun itself for photographic purposes, and found that its power was as 36 to 100. And when powerful machines are employed, it is found that the sun and electricity are about equal, and that in reality the Titans of the nineteenth century have snatched fire from heaven without being precipitated for it into the unfathomable abyss. Is this immense brilliancy an advantage? When we have looked at the electric light, we see before our eyes various coloured spots which pursue us persistently, even when the eyes are momentarily closed. These are well-known facts, and I shall not assert that they are not injurious. One of the most learned physicists of Belgium, M. Plateau, lost his sight entirely after having employed it for a considerable time in the contemplation of the prismatic colours. It is with the electric arc as with the sun; we can receive its light, but we must not look at it.

The remedy for these defects is very simple. Surround the light with an opaque globe and you cease to see it; it is, however, transmitted to the globe, in its passage through which its intensity is lowered, and in proportion to the opacity of the globe so will the brilliancy of the light be modified, and consequently less dangerous to the eyes. It is true that this necessitates a considerable loss of the original light; but where there is so much wealth we can well be lavish.

I now come to the most important point of my subject—namely, to study the composition of the electric light. Since Newton's time we have known that solar light is composed of an assemblage of rays, which, by means of the prism, we are able to separate and classify in the order of refrangibility, from red to violet. There we have arranged, in perfect order, all the simple colours possible—those which, by their combinations, reproduce all the others. The light given by lamps or gas, when analyzed in the like manner, is resolved into the same colours in different proportions; the red, orange, and yellow being very prevalent, but little green, scarcely any blue, and no violet. It is a very incomplete light, tending strongly to the red side, but weak or *nil* on the violet; and therein lies the secret of its inferiority.

The electric light is rather the contrary; not because it is not wanting in a single ray, but because, when compared with sunlight, it possesses rather more blue and much more violet, the latter arising from the arc. Reduced to its carbons, it would conform exactly to the sun. It is this predominance of the most refrangible colours, notably blue and violet, that justifies all the charges brought against the light; and we shall now see that this defect may be corrected.

Not only does the spectrum spread between the red and violet, but goes even beyond it, and from both sides rays project which, though invisible to our eyes, are really there. Those which extend beyond the red are heat rays, of which there are an enormous number in the light emitted by lamps, but scarcely any in the electric light. This light, therefore, is not hot. The rays which extend beyond the violet do not exist in the spectrum of lamp light; in the electric light they abound, and it is these that produce photographic pictures. If they are received upon sulphate of quinine, or a solution of the bark of the chestnut tree, they are transformed into luminous rays; they were not visible, but become so. The violet rays share this property; they may all be transformed into white light. It follows that the defects in the composition of the electric light may be corrected—that it suffices to eliminate the excess of blue and violet rays to filter the light through sulphate of quinine, and it then becomes absolutely identical with the solar rays. Gas and lamp flames, on the contrary, are wanting in these blue and violet rays, which nothing can possibly give them.

Let us now approach the question of expense. Everything entails expense in its production. We ask for light from motors; what is the cost of this transformation? Foucault one day made that remarkable and celebrated experiment which consists in causing a disc of metal to revolve between the poles of an electro-magnet. As long as the latter is not magnetized, the disc may be impelled at great speed, and does not cease revolving for a very long time, and then only slowly. As soon as the iron is magnetized, currents are generated in the disc, which stops suddenly. The production of these currents requires an expenditure of labour, and, in order to keep up that production, it is necessary to lean heavily upon the crank-handle—in a word, to employ force, which is transformed into an electric current. In my laboratory I perform another experiment. I attach a Gramme machine to a Hugon gas-engine of 3-horse power. So long as the circuit is open the motor gives to the machine a speed of 1000 revolutions, without fatigue, and almost without expenditure of force. As soon as the conductors are re-united, a current is developed which requires labour. Then the motor moves slowly and with difficulty, and we feel that considerable resistance has been imported into the working of the instruments. We see great motive power transformed into electricity, and from it we may infer that this wonderful thing we call "electricity," about which we know so little to-day, but which will certainly be better understood to-morrow, is only an actual form of movement accomplished in matter or in ether. It is a problem of which the solution is near at hand. In its turn this form of movement that we call "electricity," undergoes a second transfiguration in the electric arc, in order that it may become another kind of movement—viz., heat and light; so that if we take away the medium to which we owe this double transformation, we may say that the motive power is transformed into light.

But if the labour of this motor first of all changes into electric labour, this latter should, in turn, be capable of being converted into motive power. Well, couple together two Gramme machines, and set the first in action by means of a crank, and throw its current into the second; the latter will begin to move; and this experiment shows us that motive power expended, for instance, at Havre, where it would be taken from the sea, might be transmitted to Paris, and there produce its effect. But we are still very far from realizing that dream.

Now, if the question is asked, "How much does the electric light cost?" it will be sufficient to say how many horse power its production necessitates. Now, Tresca's 1850 burners required 7-horse power, or 0·4 horse per 100 burners. If the light of only 100 burners were produced by the machines, 1·5-horse power would be required. It is a light that costs less the more you produce of it at one time.

Finally, if we are asked how many francs 100 Carcel burners will cost, it will suffice to reply that they require, on an average, one horse power, and calculate the cost of a horse. But to this must be added the price of the apparatus, the interest on the money invested, sinking-fund, maintenance, cost of supervision, &c. And here comes in the art of making figures give the reply we wish to have. M. Fontaine, in a remarkable work, affirms that the electric light, in equal quantity, costs 75 times less than gas. M. Fontaine is an electrician. On the other hand, a pamphlet which I have before me proves that the electric light costs 1 fr. 65 c., when that of gas costs 1 fr. only. This pamphlet is reprinted from the *Journal des Usines à Gaz*. On both sides there is exaggeration—one party wishes to conquer, the other to hold its position. Do not think that gas is menaced. That marvellous system of lighting which penetrates everywhere, lights our streets so admirably at dusk, cooks our dinners, and illuminates our guests—which is always present and always ready to work—this system of lighting, I say, has no rival, no enemy but itself—the high rate at which, to its misfortune as well as ours, it has been fixed by an unintelligent monopoly. Gas has before it an immense domain to conquer; private houses to light, kitchens to warm, and the old-fashioned chimneys to supersede. In the place of this future, what will the few luxurious establishments do that electricity will conquer and hold? Nothing but create a great need of light, a need which the gas companies will be called upon to satisfy. Far from losing by the electric light, they will gain; far from complaining, they will rejoice at it; well inspired, they would place themselves at the head of the movement which they could not resist.

And, after all, which is the dearer, gas or electricity? This is my sole reply: The Lontin Company offer, under penalty, to provide all the apparatus, lamps, carbons, and everything required, and supply the light at the rate of 50 centimes per hour for 100 burners, on condition, be it understood, that the light is to be taken for a long term, and that a definite number of burners are to be supplied. In this room there are 14; the cost of light for a lecture of one hour's duration would therefore be 7 frs.

Although this lecture may have already lasted too long, I must at last come to the real subject of it—lighting. The trials that have been made up to the present time have left such unhappy recollections, that they have affected, and still affect seriously, the new system. If we notice daylight, we see, in cloudy weather, the whole sky lighted by rays coming from the sun. These rays are projected in all directions, and strike the ground, buildings, trees, and other objects upon the earth; there they are very widely diffused, cross each other in all directions, and furnish at all points a general illumination. If you notice a spectator in the midst of this picture, you will see that he receives rays from all points, which thus become visible to him, and you will also notice that he sends back other rays in all directions, which in turn render him visible. Such is the natural arrangement that we have to imitate.

We must first of all imitate the sky; that is to say, we must concentrate at some point near the ceiling a great bulk of light, which is to be distributed over the persons present. To do that we must multiply the burners, conceal them from direct view, and, above all, cover up windows, shop-fronts, and glass roofs. It is by these outlets that the exterior light enters, and the interior light escapes. Such are the rules that have been found to work so successfully at the Magasins du Louvre, and equally so in this hall. I was yesterday passing along the Quai de la Monnaie, and from there I saw, over the Pont Neuf, the beautiful light at the Belle Jardinière illuminating and bringing out the architecture of this palace of industry. A little to my left rose, in desolate obscurity, a black and shapeless outline. It was the Louvre; and I asked myself if our ediles had not a duty to discharge towards our monuments and towards ourselves—namely, that of surrounding us with light, when it might be done so easily and so cheaply.

M. Jamin attributes the difference in the estimates of the net cost of the electric light to the various interests engaged either in gas lighting or in lighting by electricity. But M. Jamin, who is a great *savant*, might, it seems to us, have given some more precise information — something capable of enlightening his audience. He limits himself to saying that 100 burners require, on an average, one horse power, and that it is sufficient to calculate the cost of one horse; but he also says, "to this must be added the price of the apparatus, the interest on the money invested, sinking-fund, maintenance, cost of supervision," &c. Well, that is precisely the question. It is impossible to produce anything whatever without investing capital, for which interest has to be paid and a sinking-fund provided. Did not M. Regnault prove, in a celebrated report, that gas only cost 2 centimes per cubic mètre? Yet, although he was for 22 years Consulting Engineer of the Paris Gas Company, he never indicated by what means gas could be produced at that price. That was because he had simply taken into account the raw material. How many millions were sunk and lost before gas returned any profit on the capital invested! This *unintelligent monopoly*, as M. Jamin ought *not* to have called it in a scientific lecture, now lights the City of Paris gratuitously, and many other cities and towns for ridiculously small sums. Is the electric light capable of doing as much? No. And why? Because the capital invested in the gas industry has been sunk progressively, and as the consumption has increased on a large scale, the general expenses have been distributed over a large number of cubic feet of gas; this divisor increasing more rapidly than the dividend, the quotient—namely, the net cost—diminishes. It is by relying upon this arithmetical operation that the electricians succeed in establishing very low cost prices. They set their machines at work, produce the light of 100, 200, or 1000 Carcel burners, and divide the cost per hour by the number of burners; the quotient, which is as small as the number of burners is large, constitutes the net cost.

Let us, for example, take the lighting of the amphitheatre of the Sorbonne by means of 14 electric lights, equal altogether to 1400 Carcel burners. It is evident that, by taking no account of the first cost of the motor, the electro-magnetic machine, the wires, and the lamps, the cost of these 1400 Carcel burners was small—7 frs. (5s. 10d.) for a lecture of one hour's duration, according to M. Jamin. But in the course of the year the lectures extended over perhaps as many as 30 hours—let us say 100 hours, to be quite over the mark—and let us put down 15,000 frs. only (£600) as the cost of fitting up; we arrive at the sum of 150 frs. only (£6) to add to M. Jamin's 7 frs., while the lighting of the amphitheatre by gas costs really 2 fr. 20 c. (1s. 10d.) per hour (44 burners at 5 centimes per hour), without any addition whatever.

A trial of this kind has been made in a brewhouse at Lyons. The contractor for the electric light undertook to light this brewery for a month at the same price as was paid for gas (7 frs. per night), and give a much more

intense light. At the end of a month's reciprocal gratification, the electrician proposed to the man of commerce to purchase the fittings and apparatus at a considerable sum. The latter gentleman did not take long to make his calculation, and has simply returned to gas lighting.

M. Jamin says that M. Jablochkoff can place 37 burners on the same circuit. We are quite willing to believe him, but should be much more curious to see it. Of one thing we may satisfy ourselves at the Place de l'Opéra, where there are eight electric lights, and that is, that each of these lights is furnished with *sixteen* wires.

We have only seen practically four Jablochkoff candles burning upon the same current; but sixteen have been worked with the same Gramme machine in the dye-works of M. Bredin at Lyons. In that case, however, a little subterfuge was resorted to; there were four Gramme machines attached to the same shaft, that is to say, four distinct currents, and consequently four canalizations of copper wires. It is nevertheless true that the experiment made at Lyons with the machine which was afterwards used at M. Jamin's lecture frightened the small holders of gas shares, and in a few days those of the Lyons Company dropped about 100 frs. But there is nothing to fear; these shares have gone into the hands of those who are more confident in the future of gas, which is in no way compromised by the new light. *It is not all gold that glitters.*

THE LANCASHIRE COAL AND IRON TRADES.

(FROM OUR OWN CORRESPONDENT.)

The strike in the Lancashire cotton trade continues to throw a considerable quantity of the inferior descriptions of fuel upon the market, some of which, from the Wigan district, is being pushed at extremely low prices, and any advance in slack, which is usual at this time of the year, is also being kept back by the same cause; colliery proprietors, indeed, being scarcely able to maintain late rates. With this exception there is no material change in the market, list rates, as a rule, being unaltered. There is, however, a great deal of pressing for reduction, with underselling, amongst needy holders, and prices have a downward tendency, a reduction so far as the Manchester market is concerned being very probable at the end of this month.

The better classes of round coal are now very hard to sell, and there is a great deal of short time being worked, very few of the pits now working more than about four days a week. Forge coal continues a drug, and engine classes of fuel are at present meeting with only a very small inquiry. The average quotations at the pit mouth remain about as under:—Best Wigan Arley, 9s. to 10s. per ton; common ditto, 7s. 6d. to 8s.; Pemberton four-feet, 7s. 6d. to 8s.; common coal, 5s. 6d. to 6s. 6d.; good burgy, 4s. 6d. to 5s.; and good slack, 3s. to 4s. per ton. Where, however, sales are pressed, prices are very irregular, and it is difficult to say what figures are being taken by needy holders, who are compelled to seek for orders in the open market.

For shipping the demand is still extremely small, and colliery proprietors who have to depend largely upon this branch of trade are pushing for orders at very low prices.

The iron trade continues in a very depressed condition, and prices are weak. Lancashire makers of pig iron, although nominally adhering to list rates, are open to offers at lower prices, and merchants, during the past week, have been pushing north country iron in this district at lower figures than ever. Consumers, however, are not to be tempted by low prices, and, in the present unsettled state of affairs, will only buy for their more pressing requirements. Finished iron is without change, Lancashire and Middlesbrough bars, delivered into the Manchester district, being quoted at £6 2s. 6d. to £6 5s., and North Staffordshire ditto at £6 5s. to £6 7s. 6d. per ton; but makers are not firm, and the selling prices are very much governed by the nature of the specifications offered.

THE COAL AND GENERAL TRADE OF THE NORTH OF ENGLAND.

(FROM OUR OWN CORRESPONDENT.)

The gas coal trade was not so strong last week for best qualities, and the quotations in the market do not exceed 7s. per ton. Gas coals are being shipped to Sweden and the Baltic ports, and the Russians are laying in stocks to meet contingencies. The falling off is in the coasting business principally, but that is usual at this time of year. There is an active inquiry for best steam coals, which trade is very much better, and some sorts of second-class gas have been sold for bunkers to be used on board steamers. The shipping trade of the Tyne and Wear was a good deal excited last week on account of the extraordinary demand for Cronstadt. Rates rose £4 per keel on Monday, and on Saturday they were quoted at about £11 per keel ready loading. There was also an advance of between £1 and £2 per keel to the Mediterranean. Coasting freights have been stronger. They were quoted on Saturday at 4s. 6d. to 4s. 9d. London for steamers, with a rise to all the other coasting ports in proportion. There is a scarcity of small steamers at present; coal freights are likely to be pretty stiff over the next fortnight, at least.

The exciting war rumours are having a bad effect on the general manufacturing trade. The chemical market is extremely flat, and prices fell considerably last week. Fire-bricks and all material of that sort are little inquired after, and are sent abroad in very limited quantities indeed. There is no change in the iron trade.

TRADE NOTES FROM SCOTLAND.

(FROM OUR OWN CORRESPONDENT.)

The street gas-lighting season at Dunoon having come to a close, an average has been taken of the consumption of gas at those public lamps which are provided with meters; but, notwithstanding the strenuous efforts of the local advocates of the principle of paying by meter for the gas consumed, the result has been shown to be about 15s. 6d. per lamp, as against 18s., which was the rate at which the Gas Company offered to supply the street-lamps during the season. To the 15s. 6d. must be added the cost, erection, and repair of the meters, without taking into consideration the consumption of the shoe-leather and time of the Gas Committee of the Police Commission.

At their last monthly meeting, on the 1st inst., the Dundee Gas Commissioners agreed to accept of a number of tenders for the erection of the new workshops, coal stores, purifier shed, lamp stores, &c., which they resolved upon proceeding with some time ago.

In order to meet the cost of the local gas-works purchased by the Town Council of Dumfries, under the provisions of the Burghs Gas Supply Act, an arrangement has been entered into for a loan of £25,000, at 4¼ per cent. interest.

An annuity of £7 10s. of the City of Perth Gas Company was sold by public auction on Wednesday last at £192.

In his report on the illuminating power of the gas supplied in Glasgow during the week ending the 27th of April last, Dr. Wallace states that the lowest minimum was 25·59 candles (northern district), and the highest 28·08 candles (western district), while the average ranged from 26·69 candles to 28·95 candles, and the maximum from 28·09 candles to 29·92 candles. The western district had the best results over the week.

The annual general meeting of the Innerleithen Gaslight Company was held last Thursday—Mr. Dobson, Chief Magistrate, presiding. The Secretary submitted the Directors report for the past year, along with the statement of accounts and balance-sheet, which were approved of. After making due provision for depreciation on the works and plant, and carrying forward a sum to the reserve-fund, a dividend at the rate of 8 per cent. per annum was declared, and the price of gas was reduced from 6s. 6d to 6s. 3d. per 1000 cubic feet.

Already a scarcity of water is beginning to be felt in the town of Oban, and a number of families residing beyond the burgh boundaries have had their supply cut off.

The closing prices in the Glasgow pig iron market last Friday were 3½d. per ton under those of the previous Friday, and 2d. under the lowest for twelve years back. During the afternoon 49s. 10½d. cash and 49s. 10d. cash were paid.

In the coal market there is a tendency towards increased depression. Nominally, quotations are unchanged.

Cockermouth and Workington Water-Works.—It is stated that the scheme for supplying these towns with water from Crummock Lake will entail a cost of £28,000, in 3600 tons of piping and castings; and the work is to proceed at once.

Gas Consumers Strike at Barcelona.—A paragraph in some of the daily papers states that "the strike of the consumers at Barcelona against the Corporation continues. At dusk all the establishments, except the *cafés* druggists, &c., are closed. These are lighted by candles or lamps."

Godalming Water Company.—The first general meeting of this Company was held on the 29th ult.—Dr. Brown in the chair. The Secretary reported that shares to the amount of £3250 had been already taken up, and that a large number had since been applied for.

Leicester Gas Company.—A meeting of Shareholders was held on the 29th ult.—Mr. Hutchinson in the chair—for the purpose of considering the provisions of a Bill now before Parliament, entitled "A Bill to invest in the Mayor, Aldermen, and Burgesses of the borough, the undertakings of the Leicester Gas and Water-Works Companies, and other purposes." After some conversation, a formal motion approving the Bill was adopted.

Visit to the Batley Corporation Gas-Works.—On Saturday afternoon, April 20, about 30 members of the Batley Field Naturalists Society paid a visit to the Batley Corporation Gas-Works, Soothill, and were met by Mr. Eastwood, the Engineer and Manager, who conducted them over the works and explained the different processes in the manufacture of gas. Mr. Eastwood appears to have been desirous not only to explain the mysteries of the works themselves, but also to convey some interesting and useful practical lessons to his guests, as members of the general community and gas consumers in the district. For example, whilst in the testing-room, Mr. Eastwood exhibited a number of burners, showing the results obtained from each, remarking that however good the gas sent out to the public might be, it was of little use unless they had good burners, and this was clearly demonstrated to every one. Mr. Eastwood had a number of burners fixed which had been used recently in some of the shops and churches in Batley, and on the same table were exhibited some new burners, such as he had been supplying to the public for months past at a cost of one penny each, and their immense superiority was clearly seen. Mr. Eastwood concluded his description of the works by illustrating the action of the governor used for regulating the pressure at which the gas is supplied to the public, and explained how injudicious it was to work at a heavy pressure, but that plumbers and persons building houses, and even mills, put in too small pipes, and consequently it required a greater pressure to drive the quantity of gas required through them, thus increasing the quantity of gas lost in the public streets by reason of broken or defective pipes, and causing a great loss to the public at large, because a few persons would not be at the expense of putting in proper pipes. He stated that in the end it would be to the advantage of the Corporation to put the gas-pipes into buildings for nothing, rather than continue the wasteful and ruinous practice of supplying gas at a heavy pressure in order to save the pockets of a few. At the close, Mr. Seth Smith moved a vote of thanks to Mr. Eastwood for his kindness in showing the party through the works. Mr. I. Binns seconded the motion, and, in doing so, referred to the fact that since the gas-works became the property of the Corporation, they had been so well managed that the very handsome sum of nearly £6000 had been handed over to assist the rates, or, to put it in homelier shape, each cottage householder had received half-a-crown a year as dividend since the works were purchased. Mr. Eastwood suitably responded, and the proceedings terminated.

Farnworth and Kearsley Gas Company.—At the half-yearly ordinary meeting of Shareholders, held on Wednesday, April 24—Mr. J. Greenhalgh in the chair, the report and accounts presented showed the following general results:—

Profits on gas account	£4551	8	5
,, gas-fittings account	113	14	6
,, hired gas-fittings account	31	14	4
,, house-rents	43	4	5
,, premiums on C shares	26	4	0
,, interest on calls	0	7	4
,, bank interest, less commission, &c.	20	17	2
	£4787	10	2
Balance in favour of this account for half year ended Sept. 30, 1877	2937	9	11
Total profit	£7725	0	1

The sum required for payment of dividend was £4499 10s. 8d., leaving a balance of £3235 9s. 5d. to be carried forward, and the Directors recommended that £1500 be added to the contingent account, and the remaining balance of £1725 9s. 5d. be carried forward to the next half year's account. The Directors expressed an opinion that the financial position of the Company justified a reduction in the price of gas, and proposed that a substantial reduction be forthwith made, to take effect from the commencement of the current quarter. The quantity of gas made during the half year was 44,018,000 cubic feet, as against 48,837,000 cubic feet in the corresponding half year in 1877, showing a decrease of 9·86 per cent., and the gas sold during the same period was 40,373,000, as against 41,984,000 cubic feet for the corresponding half year of 1877, the decrease being equal to 3·75 per cent. These results were mainly attributable to the strike in the cotton trade, which closed most of the mills for nearly two months, and the number of empty houses in the district. The leakage for the half year only amounted to 8·28 per cent. There had been a slight decrease in tar and coke sales, and a very substantial increase in the sale of ammoniacal liquor, which was likely to be continuous. The report of the Directors referred at length to the extension of works and plant that had recently taken place, and to the proceedings upon the Company's Bill this year in Parliament. The report was unanimously adopted, and a resolution declaring the maximum dividend to be paid to the Shareholders was passed. The retiring Directors and Auditors were re-elected, and votes of thanks to the Chairman and Officers were unanimously accorded.

Share List of Metropolitan Gas and Water Companies.

(Corrected by Mr. F. N. Golding, Sun Court, Cornhill, from the latest Stock Exchange Quotations.)

Number of Shares issued.	Amount per Share.	Name.	Amount paid up per Share.	Last Divd. p.Cent. p. Ann.	Latest Quotations.
	£	Gas Companies.	£ s. d	£ s. d	£
16000	20	Anglo-Romano . .	20 0 0	9 0 0	20–25
5000	20	Bahia (Limited). .	20 0 0	3 0 0	9½–10½
1080	20	Do., do., redeem.	20 0 0	10 0 0	25–27
1500	20	Do., 2nd pref. .	20 0 0	7 10 0	..
40000	5	Bombay (Limited).	5 0 0	7 10 0	6⅞–7¼
10000	5	Do., fourth issue.	4 0 0	7 0 0	5–5⅛
14000	20	British (Limited) .	20 0 0	10 0 0	38–40
7500	20	Cagliari (Limited).	20 0 0	6 0 0	16–18
1500001.	Sk.	*Commercial* . . .	100 0 0	10 0 0	190–195
70000	100	Do., 7 per cent. .	..	..	139–141
20000	20	Continental Union.	20 0 0	6 0 0	18½–19½
20000	20	Do., new	12 10 0	6 0 0	11ds–ds
16000	20	Do., preference .	20 0 0	7 0 0	24–26
75000	8k.	*Crystal Palace District*	100 0 0	10 0 0	195–200
135000	8k.	Do., 7 per cent. .	100 0 0	7 0 0	135–145
50000	8k.	Do., preference .	100 0 0	6 0 0	130–140
24496	10	European(Limited)	10 0 0	10 0 0	16½–17½
12000	10	Do., new shares.	7 10 0	10 0 0	5–6 pm.
35408	10	Do., new shares .	5 0 0	10 0 0	3–3½
6948407	Sk.	*Gaslight & Coke* A.	100 0 0	10 0 0	188–192
1000001.	Sk.	Do. B.	100 0 0	4 0 0	78–82
5000	10	Do. 5 per ct. pref. conv., 4th issue.	10 0 0	5 0 0	..
3000	10	Do. do., 5th do. .	4 0 0	5 0 0	5–6pm.
200001.	Sk.	Do. C 10 p.c. pref.	100 0 0	10 0 0	205–210
200001.	,,	Do. D do. do. .	100 0 0	10 0 0	205–210
150001.	,,	Do. E do. do. .	100 0 0	10 0 0	205–210
200001.	,,	Do. F 5 do. do. .	100 0 0	5 0 0	101–104
600001.	,,	Do. G 7½ do. do. .	100 0 0	7 10 0	145–152
1000001.	,,	Do. H	100 0 0	7 0 0	139–142
6200	5	Georgetown,Guiana	5 0 0	5 0 0	..
5000	10	Hong Kong (Lim.)	10 0 0	10 0 0	18–20
56000	50	*Imprl. Continental*	45 15 0	5*l.*p.sh.	92–94
9000	5	Limerick Gas . . .	5 0 0	2 10 0	3–3½
3830001.	Sk.	*London*	100 0 0	10 0 0	183–185
1500001.	Sk.	Do., 1st pref. . .	100 0 0	6 0 0	125–135
14450	Sk.	Do., 2nd pref. . .	100 0 0	6 0 0	115–125
4350	Sk.	Do., 3rd pref. . .	100 0 0	6 0 0	115–125
7622	25	Do., A shares . .	25 0 0	6 0 0	32–34
268057.	All	Do., Debent. stk.	100 0 0	5*l.* & 6*l.*	..
15000	5	Malta and Mediterranean (Limited).	5 0 0	2 0 0	2–2½
6000	5	Do., preference .	5 0 0	7 10 0	5–5⅛
23000	5	Mauritius(Limited)	2 5 0	2 10 0	¾–1
25000	20	Monte Video (Lim.)	20 0 0	8 0 0	17½–18½
8000	10	Nictheroy, Brazil (Limited) . . .	10 0 0	5 0 0	..
30000	5	Oriental (Calcutta).	5 0 0	9 10 0	7–7½
30000	5	Do., new shares .	3 0 0	9 10 0	1¼–1⅜
10000	5	Ottoman (Limited).	5 0 0	3 0 0	2-2½xd.
10000	10	Pará (Limited) . .	10 0 0	2 0 0	4¼–5¼
27000	20	*Phœnix*	20 0 0	10 0 0	37½–38½
3600001.	Sk.	Do., new max. 7½	60 0 0	7 10 0	104–109
1440001.	Sk.	Do., capitalized .	100 0 0	5 0 0	101–104
		Do., new, 1876. .	..	..	14–15pm
37500	20	Rio de Janeiro (L.)	20 0 0	10 0 0	30–32
7359	5	Singapore(Limited)	5 0 0	7 10 0	5½–5⅝
2000	5	Do., preference .	5 0 0	7 10 0	5⅞–6¼
1500	32½	Shanghai	32 10 0	12 0 0	30–32
4000	50	*South Metropolitan*	50 0 0	11 0 0	106–109
4000	12½	Do.	12 10 0	10 0 0	24–26
20000	12½	Do., new shares .	10 10 0	10 0 0	13–14
					pm.
15000	10	*Surrey Consumers.*	10 0 0	10 0 0	18–19
10000	10	Do., new	8 0 0	10 0 0	6–7
3000	10	*Wandsw. & Putney*	10 0 0	10 0 0	19–20
1500	10	Do.	10 0 0	7 10 0	11–12
1500	10	Do.	10 0 0	7 0 0	..
2957	10	Do.	10 0 0	7 0 0	..
993	10	Do.	3 0 0	7 0 0	..
28000	5	*West Ham*	5 0 0	10 0 0	8–9
		Water Companies.			
12000	100	Chelsea	100 0 0	6 0 0	148–152
1800000	100	East London . . .	100 0 0	6 0 0	153–158
8000	50	Grand Junction . .	50 0 0	5 0 0	79–81
5840	25	Do., ¼ shares . .	25 0 0	5 0 0	39½–40½
2160	25	Do., new ditto; max. div.,7½ p.c.	25 0 0	5 0 0	33–34
547960	100	Kent	100 0 0	8 0 0	202–207
970	100	Lambeth	100 0 0	6 5 0	150–154
1161	100	Do., max.,7½ p.c.	100 0 0	6 5 0	148–152
442	100	New River	100 0 0	7 0 0	320–330
4475	100	Do.	85 0 0	7 0 0	280–300
400000	100	Do.,deb.sk.,4 p.c.	100 0 0	4 0 0	101–103
3036	100	Southwrk. & Vauxh.	100 0 0	2 0 0	96–99
1296	100	Do., pref. stock .	100 0 0	5 0 0	112–115
..	100	Do., D shares . .	100 0 0	4 0 0	98–100
..	100	Do., new ordinary	..	4 10 0	..
1600	100	Do., new ord. No.1	40 0 0	4 10 0	..
12172	61	West Middlesex . .	61 0 0	6*l.*p.sh.	139–142

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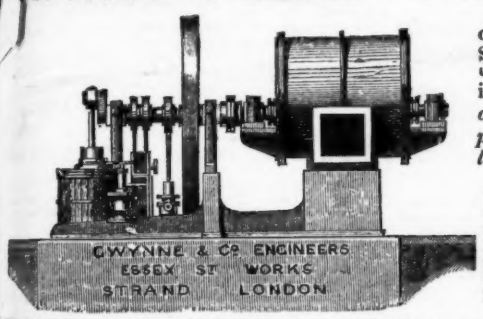

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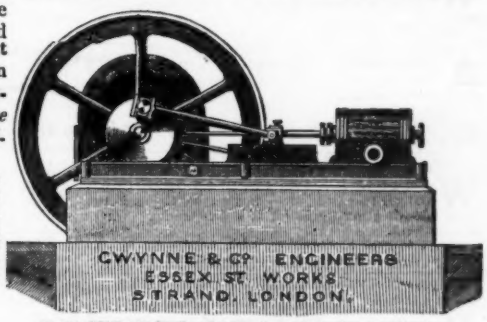

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May be viewed on Monday, the 20th inst., and catalogues had on the premises, and of Mr. SCAMELL, 40, Upper Thames Street, LONDON.

NOTICE TO MANAGERS OF GAS COMPANIES.

THE LAW UNION FIRE AND LIFE INSURANCE COMPANY, of No. 126, Chancery Lane, London, grants Policies of Insurance on Gas-Works, and Buildings connected therewith, which cover risk of explosion and spontaneous ignition of Coal, on very advantageous terms. Full particulars will be sent post free on application to

FRANK M'GEDY, Secretary.

126, Chancery Lane, London.

SULPHATE OF AMMONIA PLANT.

THE above Plant, erected on the newest and most improved method, at less than half the cost of other plans, gives better results, requires less labour, and allows no gases or offensive smell to escape. Reference kindly permitted to manufacturers as to efficiency and cheapness of plant &c.

For particulars, address JOHN G. HARVEY, Chemical Works, Little Island CORK.

SPENT OXIDE OF IRON.

WE are open to Buy this in any quan- tity.

Address, with price, to NICHOLSON AND SONS, Chemical Works, Hunslet, near LEEDS.

GASHOLDER, now at work, and in good condition, FOR SALE; 45 ft. diameter, 18 ft. deep; Six Columns and Girders, with Chains and Balance-weights.

Apply to the Horseley Company, Limited, Tipton, STAFFORDSHIRE.

ON SALE—One Station-Meter, to pass 1000 cubic feet per hour. Almost new. Will be sold cheap.

Apply to J. HALL, Gas-Works, St. Helen's, LANCS.

TO GAS COMPANIES AND OTHERS.

THE Stalybridge Gas Company have for Sale, at their Mossley Works—

One 14-inch Station Governor.

Two lengths wrought-iron Hydraulic [illegible] diameter, each 32 ft. 10 in. long, fitted for Emmott's ovens; with all the necessary pipes, cast-iron fronts, mouthpieces, &c., for 8 ovens.

Also wrought-iron Buckstaves, made of 6 in. angle iron, 6 double and 4 single, each 9 ft. 5 in. long, and wrought-iron Lids for retorts and ovens as above.

The Company have also at their Stalybridge Works—

One 12-in. Centre Valve for 4 purifiers, Newton, Chambers, and Co.'s make.

Four wrought-iron Purifier Covers, 12 ft. 6 in. square and 15 in. deep, weighing about 16 cwt. each, together with cast-iron Girders and Lifting Gear complete.

All the above are in good condition, and may be seen on application to Mr. ROBERT HUNTER, Manager, Gas-Works, Stalybridge, of whom any further particulars may be obtained.

Stalybridge, April 11, 1878.

BOROUGH OF BRADFORD.

THE Gas Supply Committee of the Brad- ford Corporation require the Services of a thoroughly competent Person as SUB-MANAGER and SUPERINTENDENT at one of their Gas Stations. Some knowledge of the manufacture of gas indispensable. Salary £150 per annum.

Applications endorsed "Sub-Manager," accompanied by testimonials, to be sent to me on or before the 16th inst.

By order,
W. T. M'GOWEN, Town Clerk.

Town Hall, Bradford, May 3, 1878.

IMPERIAL CONTINENTAL GAS ASSOCIATION.

(INCORPORATED BY ACT OF PARLIAMENT.)

Notice is hereby given that the HALF-YEARLY ORDINARY MEETING of the Proprietors of the Imperial Continental Gas Association will be held at the City Terminus Hotel, Cannon Street, London, on MONDAY, the 27th inst., at Two o'clock in the afternoon precisely, when a Report will be made to the Proprietors, a Dividend declared for the half year ended Dec. 31, 1877, and the usual ordinary business of such meeting transacted.

Notice is also hereby given that the Transfer Books will be closed on Monday, the 13th inst., and will remain closed until after the Half-Yearly Ordinary Meeting on the 27th inst.

ALBERT F. JACKSON, Secretary.
(By order of the Board.)

No. 30, Clement's Lane, Lombard Street,
London, May 4, 1878.

LEIGH LOCAL BOARD.

CONTRACT No. 1.

THE Local Board of Leigh (Lancs) invite TENDERS, with drawings and specification, for Four New PURIFIERS, particulars of which may be obtained from the Engineer.

Sealed tenders to be addressed to the Chairman of the Gas Committee on or before May 20, 1878.

The lowest tender not necessarily accepted.

JOS. TIMMINS, Engineer, &c.

May 2, 1878.

LEIGH LOCAL BOARD.

CONTRACT No. 2.

THE Local Board of Leigh (Lancs) invite TENDERS for Supplying a Wrought-Iron Annular CONDENSER. Plans and specification may be seen on application to the Engineer.

Sealed Tenders to be sent in, addressed to the Chairman of the Gas Committee, on or before May 20, 1878.

The lowest tender not necessarily accepted.

JOS. TIMMINS, Engineer, &c.

May 2, 1878.

BOROUGH OF HALIFAX.

TO COLLIERY PROPRIETORS.

THE Gas-Works Committee invite TENDERS for the Supplying of 20,000 Tons of GAS COAL and 1000 Tons of CANNEL, to be delivered upon the Railway Siding at the Corporation Gas-Works. The whole to be supplied before April 30, 1879.

Printed particulars and forms of tender may be obtained on application to Mr. Wm. Carr, Engineer, Gas-Works, Halifax.

Tenders, properly endorsed, must be sent to me on or before Thursday, the 30th of May, inst.

By order,
A. C. FOSTER, Town Clerk.

[illegible], May 3, 1878.

LLANDUDNO IMPROVEMENT ACTS.

GAS-WORKS CONTRACT, No. 4.

WANTED, Tenders for Wrought and Cast Iron Plant and Materials.

Form of tender, bill of quantities, schedule for prices, and specification will be forwarded in duplicate on payment of one guinea, one-half of which will be returned to every contractor supplying a *bonâ fide* tender.

Sealed tenders, endorsed "Tender for Wrought and Cast Iron Work, Gas-Works Contract, No. 4," to be addressed and forwarded, post paid, to the undersigned not later than the morning postal delivery of Saturday, May 18, 1878.

The Commissioners do not bind themselves to accept the lowest or any tender.

THOS. T. MARKS, C.E.,
Engineer to the Commissioners.

Llandudno, April 27, 1878.

THE Directors of the Kingston-upon- Hull Gas Company are prepared to receive TENDERS for the surplus TAR produced at their Works, for One or Two years.

Tenders must be sent in by the 19th inst.

Further particulars by applying to

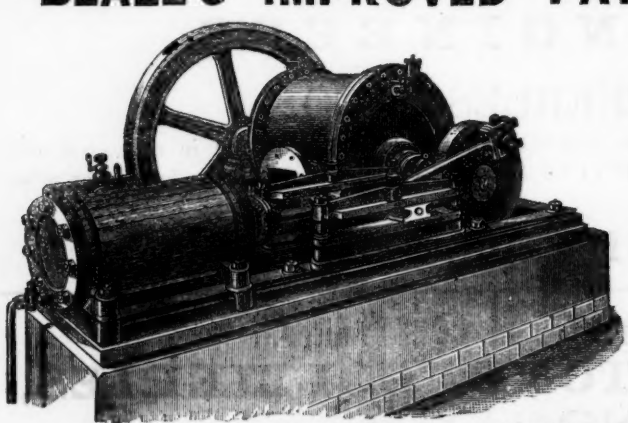
E. JACKMAN, Manager.

May 1, 1878.

BEALE'S IMPROVED PATENT GAS EXHAUSTERS

WITH

Wrought-Iron Spindles and ENGINES COMBINED.



SOLE MAKERS,

GEORGE WALLER & CO.

MAKERS OF ENGINES, EXHAUSTERS, INDEX AND DISC GAS-VALVES, HYDRAULIC MAIN VALVES, BYE-PASS VALVES, TAR, LIQUOR, AND OTHER PUMPS, SCRUBBERS AND PURIFIERS, CONDENSERS, BOILERS, &c.

Awarded Silver Medal at the Manchester Exhibition of the Society for the Promotion of Scientific Industry.

Phœnix Engineering Works:

HOLLAND STREET, SOUTHWARK, S.E.

COMMERCIAL GLASS WORKS, 27, WELLCLOSE SQUARE, LONDON, E.

CHEAPEST HOUSE IN THE TRADE FOR GAS GLASSES OF EVERY DESCRIPTION.

Write for Lists, free on application to any part of the World.

WILSON CARTER AND PEARSON,

GAS COAL AND CANNEL FACTORS,

Supply to any Railway Station or for Export all kinds of Fuel for Gas purposes.

Address—CHIEF OFFICES:

TEMPLE BUILDINGS, 50, NEW STREET, BIRMINGHAM.

ECONOMY IN THE PRODUCTION OF GAS.

PLUTONIC CEMENT,

For Jointing and Repairing Retorts and Ovens *in* action and *out* of action.

A Pamphlet on the advantages of the above, with modes of Application, References, Prices, &c., free by post, from the Sole Manufacturer,

WILLIAM RICHARDSON, GAS AND HYDRAULIC ENGINEER,

CHARLES HENRY STREET AND BISSELL STREET, BIRMINGHAM.

GAS PURIFICATION.

BAILES & HALLSWORTH,

CONTRACTORS FOR THE

PURIFICATION OF COAL GAS

BY THEIR

PATENT HYDRATED PEROXIDE OF IRON MATERIAL.

The Material is adapted specially for taking up sulphuretted hydrogen, and will simultaneously absorb any ammonia that may pass the scrubbers.

The spent oxide resulting from our Material is more valuable than that from natural oxide of iron, and manufacturing chemists buy it in preference.

The Material has now been in use during the past three years in most of the principal Gas-Works in Yorkshire and elsewhere.

It contains considerably less moisture than natural oxide of iron, and is much cheaper and more efficient as a purifying agent.

B. & H. are purchasers of Spent Oxide, or will take Spent in exchange for New Material.

FOR SAMPLES AND TERMS, ADDRESS—

BAILES & HALLSWORTH, COPPERAS WORKS, ARMLEY, LEEDS.

THE THAMES BANK IRON COMPANY,

(Successors to LYNCH WHITE,)

SUPPLY FROM STOCK

CAST-IRON RETORTS, SOCKET-PIPES for GAS or WATER PURPOSES, FLANGE-PIPES for STEAM, RAIN-WATER PIPES and GUTTERS, HOT-WATER PIPES and BOILERS, and all requisite Connexions for same; also LAMP-COLUMNS, LAMPS, WROUGHT FRAMES, WROUGHT-IRON TUBING, &c., &c.

All kinds of Gas-Works Apparatus and General Castings made to Pattern or Drawing.

ADDRESS—

OLD BARGE WHARF, UPPER GROUND STREET, LONDON, S.E.

TO GAS COMPANIES AND THE TRADE.

J. DEFRIES & SONS,

MANUFACTURERS OF

CRYSTAL, BRONZED, & ORMOLU CHANDELIERS, IMPROVED CRYSTAL STAR & SUN LIGHTS VESTIBULE LAMPS, AND THE PATENT CRYSTAL ILLUMINATION.

A LARGE STOCK ALWAYS IN HAND OF

IRON, BRASS, COMPOSITE, AND LEAD TUBES, FOR GAS AND WATER,

AND EVERY DESCRIPTION OF

GAS AND WATER FITTINGS.

THE PATENT DRY AND WET METER, WITH THE LATEST IMPROVEMENTS.

STREET LAMPS AND COLUMNS IN GREAT VARIETY.

WORKS: LONDON AND BIRMINGHAM.

GAS MOONS, Cut and Engraved, of the newest designs

GAS REFLECTORS In Silver and Glass

GAS NIBS AND **BURNERS** Of every description.

Pattern-Books of Gas-Fittings, Crystal and Ormolu Chandeliers for 1876, are now complete.

City Show-Rooms and Manufactory, 147, HOUNDSDITCH, LONDON.

ESTABLISHED 1830.

TO GASHOLDER AND TANK BUILDERS.

THE Directors of the Sleaford Gas Company, Limited, are desirous to receive TENDERS to take down a 54 ft. by 18 ft. GASHOLDER; also a Wrought Iron TANK, 56 ft. by 18½ ft., with Columns, Girders, Mains, Valves, &c., now at the Gas-Works, Bilston, Staffordshire, and erect the same at the Gas-Works, Sleaford, Lincolnshire.

Specifications may be had gratis.

Apply to T. H. BOUTTELL, Manager and Analyst, Gas-Works, Sleaford.

May 4, 1878.

TENDERS FOR GAS-WORKS.

THE Audley Local Board are prepared to receive TENDERS for the Construction of GAS-WORKS for the supply of the district of Audley, Staffordshire.

Contract No. 1 comprises Retort-House, Chimney, Purifier and Lime Sheds, Meter and Governor House, Tar-Tank, Office and Workshop, Manager's House and Boundary Walls.

Contract No. 2 comprises Gasholder-Tank 41 ft. 6 in. diameter and 12 ft. deep.

Contract No. 3 comprises the whole of the apparatus required within the Works.

Contract No. 4 comprises excavating and filling in Trenches for about five miles of mains.

Plans and specifications may be seen on application to Mr. J. DAVIES, Gas-Works, Kidsgrove, to whom tenders must be sent, properly endorsed with the number of the contract, on or before the 15th inst.

The Local Board do not bind themselves to accept the lowest or any tender.

By order,

J. DAVIES, Engineer.

Gas-Works, Kidsgrove, May 1, 1878.

COAL CONTRACT.

THE Directors of the Southwark and Vauxhall Water Company are prepared to receive TENDERS for about 20,000 Tons of STEAM COAL, of the kinds set forth in the specification, delivered into store at the several pumping stations.

Specifications and form of tender can be obtained at the Engineer's Office on payment of 21s., and the same must be forwarded not later than May 14, 1878, addressed to the "Chairman, Southwark and Vauxhall Water Company, Sumner Street, Southwark, S.E.," endorsed "Tender for Coal."

By order.

TO COAL MERCHANTS, SHIPOWNERS, AND OTHERS.

THE Directors of the Torquay Gas Company are prepared to receive TENDERS for the Supply of about 6000 Tons (or such other quantity as may be agreed on) of Pelaw Main, Waldridge, Pelton, New Pelton, Pearth, or other approved GAS COAL. About 700 tons per month to be delivered during June, July, August, September, and October, and the remainder at the rate of about 500 tons per month during the succeeding five months.

Tenders to state the price of the Coal, and the freight to Dartmouth, separately and together; and also for delivery into the Company's Works, adjoining the Dartmouth Railway, free of all charges.

Payment by cash for freight on delivery, and by three months bill for the Coal.

Further particulars to be obtained from Mr. Greenfield, the Manager of the Company, Hollacombe, Paignton; and tenders to be sent to the undersigned, on or before the 18th day of May inst.

By order,

J. KITSON, Secretary.

Torquay, May 2, 1878.

AYLESBURY GASLIGHT AND COKE COMPANY, LIMITED.

THE Directors of the above Company are prepared to receive TENDERS for the Supply of 2000 Tons of GAS COAL. The deliveries to extend to One year from the 30th day of June next.

Tenders, quoting price per ton delivered free at the London and North-Western Railway Station, Aylesbury, to be endorsed "Tender for Coal," and must be delivered before the 1st of June next to the Secretary, Mr. JOSEPH PARROTT, Bourbon Street, Aylesbury, from whom any further information may be obtained.

Aylesbury, May 4, 1878.

A PAMPHLET ON DIP-PIPES, &c., post free 6½d., on application to W. WHITE, Gas-Works, Abersychan, Mon. See Reviews in the *Gas Trade Circular and Review*, March 29, 1878, and *Design and Work*, March 30, 1878.

Price 1s., on stout paper, in stiff paper cover,

ANALYSES OF SCOTCH COALS, CANNEL, SPLINT, SHALE, &c., USED in the MANUFACTURE of GAS. By WILLIAM WALLACE, Ph. D., F.R.S.E., F.C.S., &c., Public Analyst and Gas Examiner for the City of Glasgow.

LONDON:

WILLIAM B. KING, JOURNAL OF GAS LIGHTING Office, 11, BOLT COURT, FLEET STREET, E.C.

A. FAIRLIE WILSON,

CONSULTING GAS ENGINEER,

34, ST. GEORGE'S ROAD, SOUTHWARK, S.E.

Reports and Valuations in the Management, Construction, and Structural Value of Gas-Works.

TO INVENTORS AND PATENTEES.

MR. W. H. BENNETT, having had considerable experience in matters connected with Gas, Water, and Sanitary Improvement, begs to say that he continues to assist Inventors in the perfection of their designs, and to obtain for them PROVISIONAL PROTECTION, whereby their invention may be secured for Six Months; or LETTERS PATENT, which are granted for Fourteen Years.

Patents completed, or proceeded with at any stage, thereby rendering it unnecessary for persons resident in the country to visit London.

Patents procured for Foreign Countries.

Information as to cost, &c., supplied gratuitously upon application to the Advertiser, 22, Great George Street, WESTMINSTER.

BIRTLEY IRON WORKS,
CHESTER-LE-STREET,
DURHAM.

Manufactory for every description of Casting and Machinery for Gas-Works and Water-Works.

Warehouse in London for Cast-Iron Pipes and Connexions of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.

Agent in London, Mr. J. MANWARING, 101 Cannon Street, E.C.

BOUCK & CO., LIMITED,
TAR DISTILLERS & MANUFACTURING CHEMISTS,
MILES PLATTING, MANCHESTER.
BRANCH WORKS, BLACKBURN.

BUYERS OF COAL TAR,
And Crude Products therefrom,
AMMONIACAL LIQUOR, &c.

CATHELS'S Patent District Dry Gas-GOVERNOR is the only perfect self-acting contrivance for Regulating the Pressures in the higher levels of a district.

For prices, &c., apply to the Manufacturers, Messrs. GUEST AND CHEIMES, ROTHERHAM.

CATHELS & TERRACE'S Patent Four-WAY DISC GAS-VALVE is the simplest and best Valve for Purifiers, and as a By-pass for other apparatus in Gas-Works. It is always gas-tight, and has no springs, ground faces, or other delicate parts. By its use the flow of the gas cannot be accidentally stopped, and it never sticks.

For prices, &c., apply to the Manufacturers, Messrs. GUEST AND CHEIMES, Foundry and Brass Works, ROTHERHAM.

CATHELS'S Improved Retort-Settings. Guaranteed to heat and wear well, with great economy of Fuel.

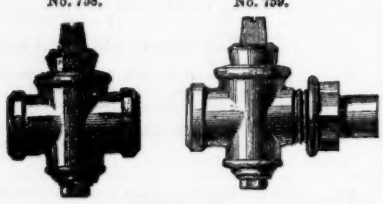
Coloured Ethograph copies of Working Drawings of Beds of One to Seven Retorts (so clearly arranged and fully shown as to be easily understood by any retort setter or bricklayer) having been made of these valuable settings, they can now be supplied with detailed Specification immediately on receipt of orders.

Apply to Mr. THOS. NEWBIGGING, Consulting Gas Engineer, 5, Norfolk Street, MANCHESTER.

LAMBERT'S
CAST-IRON GAS-MAIN COCKS,
WITH PATENT WHITE METAL PLUGS.

TRADE (L) MARK.

No. 758. No. 759.



The bodies of these Taps are made of iron, black or galvanized, and the plugs of patent metal. They are warranted not to set fast or corrode, as do Iron or Brass Cocks; will always work easily; are strong, well made, durable; of little or no intrinsic value, and therefore not likely to be stolen; and the prices as stated below are (especially upon the larger sizes) fully 50 per cent. less than Brass Cocks.

	½	¾	1	1¼	1½	2-inch.
No. 758, with inside screws for iron pipe, black	2/0	3/0	4/1	6/6	7/8	12/0 each.
No. 759, with union on one end screwed inside for iron pipe, black	2/9	3/10	5/4	8/0	9/0	15/6 each.
Nos. 758 and 759, galvanized	0/3	0/4	0/6	0/8	0/10	1/4 extra.

MANUFACTORY:
SHORT STREET, LAMBETH, LONDON.

THOMAS CARR & SON,
MANUFACTURERS OF
FIRE-BRICKS, LUMPS, TILES, RETORTS, &c.,
SCOTSWOOD FIRE-BRICK WORKS, SCOTSWOOD-ON-TYNE.
Also Makers of all kinds of Common Building Bricks, and of Pressed White and Red Bricks for Facing.

GRIRDROD'S PATENT
PORTABLE PIPE SCREWING MACHINE,

For 1 in., 1¼ in., 1½ in., and 2 in. Gas Threads, complete £7 10s.

In use at the chief gas-works, and giving great satisfaction.

For other useful goods, see Bailey's "Illustrated Inventions," post free 3s. 6d.; gratis to ledger customers.

W. H. BAILEY & CO.,
Brassfounders, Gauge njector and Tool Makers,
ALBION WORKS, SALFORD,
LANCASHIRE.

GREAT SAVING OF LABOUR.
ENOCH'S PATENT
PORTABLE DRILLING-MACHINE,
Now in use by all the Principal Gas and Water Companies in the United Kingdom.

E Size, for Services in Pipes, 2 to 3 in. bore	£3 10 0
F Size, for Services in Pipes, 2 to 4 in. bore	4 0 0
G Size, for Services in Pipes, 2 to 6 in. bore, with Telescope Cramp.	4 10 0

Drills, 1s. 6d. each.

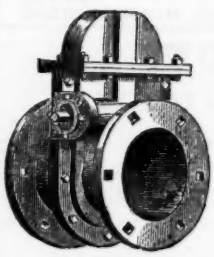
Machines sent on approval, if desired.

Prices for other Sizes and Modifications, with full Particulars and Testimonials, on application to

ALEXANDER ANDERSON,
Office: 9, London Street, E.C. Warehouse: Vine Street, Minories, London, E.

B. DONKIN & CO.'S
IMPROVED GAS-VALVES
WITH WROUGHT-IRON PINIONS.

TRADE MARK.



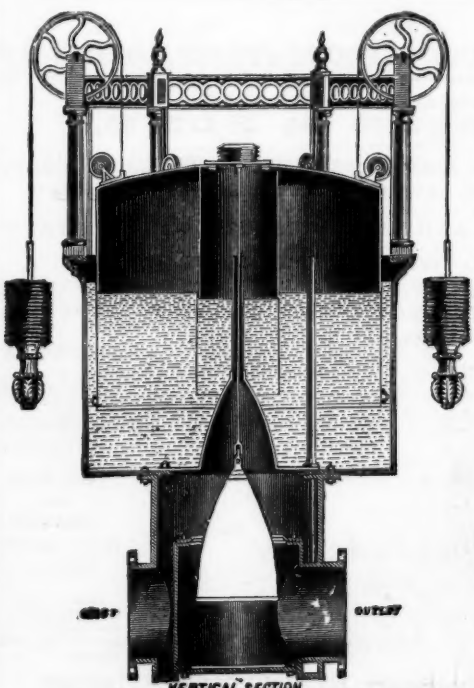
List of prices, with full dimensions of all sizes up to 48-inch, to be had on application.

These V ves are proved on both sides to 30 lbs. on the square inch before leaving th works, and are kept in stock.

ALSO SOLE MAKERS OF
J. BEALE'S NEW PATENT GAS EXHAUSTERS,
AND MAKERS OF
STEAM ENGINES FOR DRIVING GAS EXHAUSTERS,
VALVES FOR AMMONIACAL LIQUOR,
IMPROVED BRIDGE VALVES FOR REGULATING THE SEAL IN HYDRAULIC MAINS,
BYE-PASS VALVES, SCREW WATER-VALVES.

B. DONKIN & CO., 55a, BLUE ANCHOR ROAD, BERMONDSEY, LONDON, S.E.

J. & J. BRADDOCK,
GLOBE METER-WORKS,
OLDHAM,
Beg to submit to Gas Engineers their
PATENT COMPENSATING GAS GOVERNOR,
Which is designed to give an uniform pressure at the Outlet to the Main at all draughts up to the full quantities which the Governors are made to control, such outlet pressure being less than the initial pressure.



VERTICAL SECTION

The uniformity of pressure is obtained by introducing a compensating chamber into the Bell or Holder of the Governor, which compensator is of the same area as the valve, both of which are operated on by the initial pressure, thereby placing the valve in equilibrium, no matter what the initial pressure may be. The action on the Bell is by the Gas passing along a pipe from the outlet, and the pressure is regulated by weights in connexion with the Bell as required.

From the sectional elevation attached hereto, it will be seen that only the Gas required to operate the Bell comes in contact with the water of the tank, which water will remain comparatively sweet and free from odour. That in case of accident to the Bell, no more Gas can escape than would pass up the pipe covering the valve-rod and Bell supply-pipe.

These Governors have been made and sent out of various sizes for from 2 to 24-inch Mains, and give most satisfactory results.

They can be made with Float in the Bell, or counterpoise as per section.

NOTICE.

THE GAS & WATER COMPANIES DIRECTORY, 1878.

(WATER SECTION.)

The Editor will feel greatly obliged if Secretaries and Engineers would fill up, and return to him at once, the forms sent them, as the work is now going to press. If any have not received Forms, they will be forwarded immediately, on application to the Editor,

CHARLES W. HASTINGS,
8, BUCKINGHAM STREET, ADELPHI, LONDON, W.C.

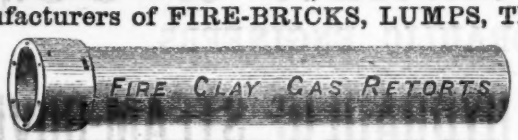
JAMES MILNE & SON,

GAS ENGINEERS,
Gas-Meter, Gas Apparatus, and Gas-Fittings Manufacturers,
EDINBURGH, AND
2, KING EDWARD STREET,
NEWGATE STREET, LONDON.
Meter Works in London—2, CROSS STREET, WILDERNESS ROW, E.C.

STATION-METERS, GOVERNORS, CONSUMERS METERS, GAS LUSTRES, CHANDELIERS, BRACKETS, &c.,
And every description of Gas-Fittings and Gas Apparatus.

JOHN HALL AND CO., STOURBRIDGE,

Manufacturers of FIRE-BRICKS, LUMPS, TILES,



AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.
N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short Notice.

GEORGE ANDERSON,

GAS AND CONSULTING ENGINEER,
35A, GREAT GEORGE STREET,
WESTMINSTER, S.W.,
PATENTEE and MANUFACTURER of the following Invention
RETORT SETTINGS—giving great Economy of Fuel.
STEAM-ENGINES and EXHAUSTERS, FOUR-WAY VALVES, WASHERS, SCRUBBERS.
FUEL-MACHINE, for Compressing Breeze and Tar.

N.B.—Pamphlet, with Eighteen Illustrations and Letterpress on the Construction of Gas-Works, post free, 2s. 6d.

PRICES AND ALL PARTICULARS TO BE HAD OF THE PATENTEE,
35a, GREAT GEORGE STREET, WESTMINSTER, S.W.

CANNEL COAL.

ELLIS LEVER & CO., Central Coal Offices, 46, Cannon Street, London, E.C., and 6, Piccadilly, Manchester, are prepared to contract for the supply of THE BEST CLASSES of CANNEL and GAS COAL, for long or short periods. Analysis and prices on application.

ELLIS LEVER & CO.,

CANNEL AND GAS COAL CONTRACTORS,
Shippers of Steam and House Coal
AT ALL
ENGLISH, SCOTCH, AND WELSH PORTS.

46, CANNON STREET, LONDON,
AND
6, PICCADILLY, MANCHESTER.

JOHN SPENCER,

VULCAN WORKS, WEST BROMWICH, & 97, CANNON ST., LONDON,
Manufacturer of Every Description of
TUBES & FITTINGS,
Plant, Tools, Stores, and all requisites for Gas and Water Works: Gasholders, Purifiers, Scrubbers, Roofing, Sashes, Retort Fittings, Grids, Socket-Pipes, Lamp-Posts, Wheelbarrows; Brasswork, Chandeliers, and Gas-Fitters Tools; Liquor-Pumps, Valves; Clay Retorts and Fire Goods, &c.

HOPKINS, GILKES, & CO.,

LIMITED,
MIDDLESBOROUGH,
SUPPLY GAS & WATER PIPES of EVERY SIZE.
Plain, Turned and Bored, and Coated.
CAST-IRON RETORTS.
Castings for Gas-Works of every description.
EXHAUSTERS.
LONDON OFFICE: 25, LAURENCE POUNTNEY LANE.

ALFRED LASS,

SPECIAL ACCOUNTANT FOR GAS COMPANIES,
30, GRACECHURCH STREET, LONDON.

Accounts analyzed and Statistics Prepared for Parliamentary Proceedings, Arbitrations, &c.
The Forms of Account, which have been specially designed by A. L. to meet the requirements of the Gas-Works Clauses Amendment Act, 1871, are now in use by many Gas Companies, and have been universally approved.
The above forms are registered.
Water Companies Accounts also prepared and adjusted.
CONSULTATIONS.

T. NEWBIGGING,

CONSULTING GAS ENGINEER,
5, NORFOLK STREET, MANCHESTER.

MR. EDWARD SANDELL,

Associate of the Society of Accountants in England,
Publisher of the
"Gas Companies Expenditure Journal,"
Begs to announce his REMOVAL from Skinner's Place, Size Lane, to
No. 2, GT. GEORGE STREET, WESTMINSTER.

Prices, half bound, cloth sides, 2 quires, 30s.; 3 quires, 36s.; other sizes and bindings to order.

THE
GAS COMPANIES EXPENDITURE JOURNAL,
Being a Ruled Account-Book with Printed Headings, and Analyzing Guide for Keeping, upon the easiest and most correct method, the Expenditure of a Gas Company, in accordance with the provisions of the Gas-Works Clauses Act of 1871, and suitable for all Companies.
Published by EDWARD SANDELL, Accountant, 2, Great George Street, WESTMINSTER, and W. B. KING, Office of the JOURNAL OF GAS LIGHTING, 11, Bolt Court, FLEET STREET, E.C.

Mr. ROBERT DEMPSTER, Sen.,

CONSULTING GAS ENGINEER,
Of Messrs. Robert Dempster and Sons, Rose Mount Gas Engineering Works,
ELLAND, near HALIFAX,
May be consulted on all matters connected with Valuations, Arbitrations, and Parliamentary Applications connected with Gas-Works. Our R. D., Sen., having been engaged on extensive Arbitration Cases, which, combined with his experience in Construction and Contracting, his knowledge of Engineering and Valuations, is both extensive and reliable.

REMOVAL.
CHARLES HEISCH, F.C.S., Analytical and Consulting Chemist, Superintending Gas Examiner to the Corporation of London, &c., &c., has REMOVED from 8, Savage Gardens, to 79, MARK LANE, where he may be consulted as usual.

JOHN ROMANS, C.E., F.G.S.E.,

CONSULTING GAS ENGINEER
AND
CANNEL COAL FACTOR,
30, St. Andrew Square, EDINBURGH.

Plans and Estimates furnished; Gas-Works, Apparatus, Pipes, Machinery, Fire Goods, &c., supplied, or Attested and Shipped for Exportation.
GAS-WORKS TAKEN ON LEASE.

Mr. ROMANS has for upwards of 30 years been practically engaged in the Manufacture of Gas, and has, by extensive experiments, ascertained that by JUDICIOUS INTERMIXTURE of the lighter with the heavier gases, much of the rich Hydrocarbons CAN BE SAVED, which otherwise ARE LOST, during the process of manufacture. He is therefore enabled to give advice to those who favour him with their orders for Cannel, as to the class which will secure for their standard of illuminating power the HIGHEST ADVANTAGEOUS RESULTS.

ANALYSIS AND PRICES FORWARDED ON APPLICATION.

YEO'S PATENT ENGINE PACKING,

Price 1s. 8d. per lb., any size.
Tarred & White Spun Yarn for Pipe Joints, at various prices.
Samples and testimonials free per post.
E. YEO, NEWTON ABBOT.

COMPLETION OF THE FIRST VOLUME
OF
KING'S TREATISE
ON THE
SCIENCE AND PRACTICE OF THE MANUFACTURE & DISTRIBUTION
OF
COAL GAS.
EDITED BY THOS. NEWBIGGING, C.E., AND W. T. FEWTRELL, F.C.S.

On the 1st of May was published No. 18, containing Title-page, Table of Contents, Lists of Plates and Illustrations, and a full-page

COLOURED ENGRAVING OF THE BECKTON GAS-WORKS,

Forming a Frontispiece to the First Volume of this important Work, completed with the present number.

On the 21st of May will be ready, price 28s., handsomely bound in Morocco, cloth sides, gilt edged and lettered, Vol. I.

This Volume contains 460 pages of Letterpress, and is illustrated by 521 Woodcuts and 37 page and double-page Engravings, printed on Plate paper.

SUBSCRIBERS NAMES RECEIVED BY THE PUBLISHER,
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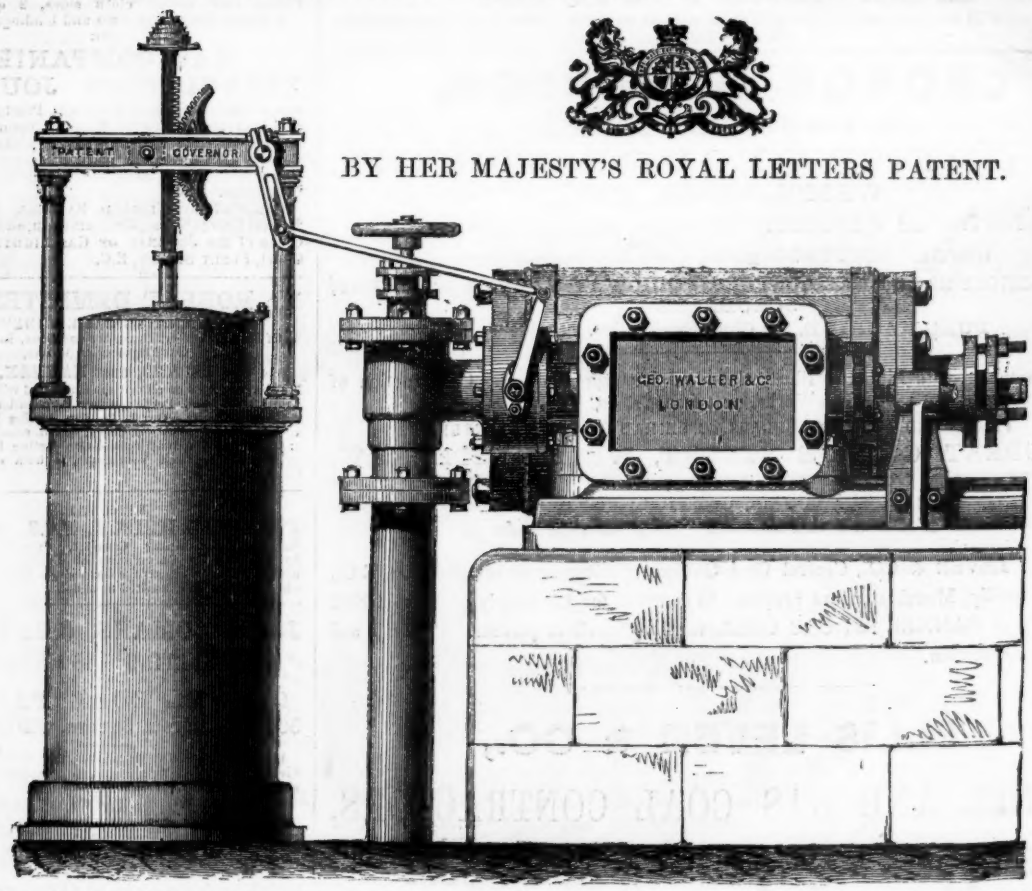
GEORGE WALLER & CO.,
GAS AND HYDRAULIC ENGINEERS.

PATENT COMPENSATING HYDRAULIC STEAM-GOVERNOR.

BY HER MAJESTY'S ROYAL LETTERS PATENT.



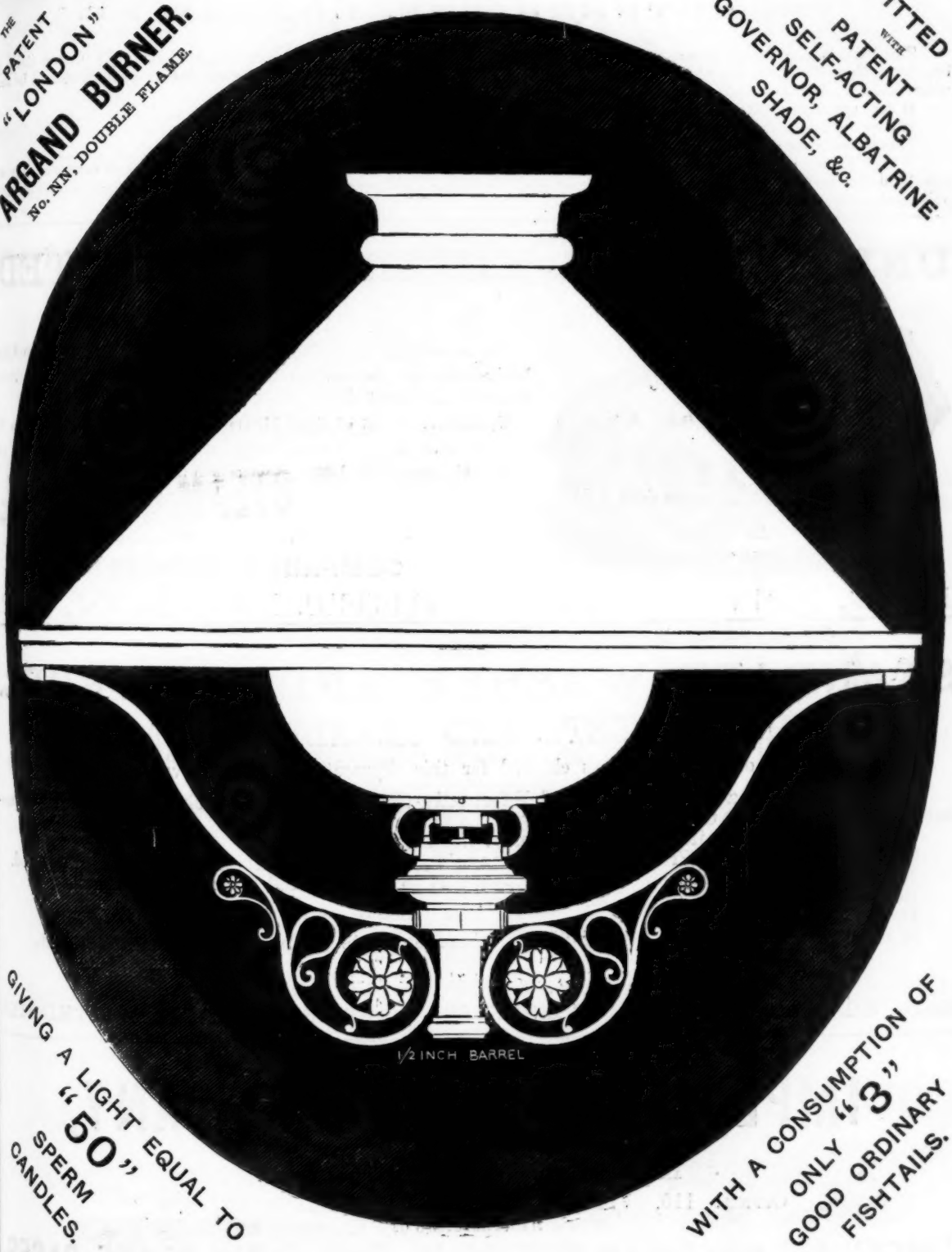
G. W. & Co. have designed this Patent Compensating Governor to work on an **entirely novel principle,** and to meet a want much felt in Gas-Works. The bell contains a **self-acting water-balance** in addition to the float. The clip arm on the quadrant pin can be **fixed at any angle,** so as to connect either above, below, or horizontally (as in the engraving), and with **only one rod.** This Governor will so regulate the speed of the Engine that a **steady gauge** is maintained at all times, even with **considerable variation** in the gas-main and in the boiler pressure, thus combining advantages **not attained by any other Governor.**

Phœnix Engineering Works, Holland Street, Southwark, S.E.

POWERFUL LIGHT CENTRE.

THE PATENT "LONDON" ARGAND BURNER. No. NN, DOUBLE FLAME.

FITTED WITH PATENT SELF-ACTING GOVERNOR, ALBATRINE SHADE, &c.



GIVING A LIGHT EQUAL TO "50" SPERM CANDLES.

WITH A CONSUMPTION OF ONLY "3" GOOD ORDINARY FISHTAILS.

WILLIAM SUGG,

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1862.

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MADE ONLY BY

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CLASS II.

This Paint having been in general use over sixteen years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known. Its advantages are that—

It does not require DRIERS like other Paints.

It does not poison the painter like white lead. No colic by its use.

It has greater durability in colour, as sulphurous gases do not blacken it as they do white lead.

It is of a light stone colour, and has a body equal to white lead, and as its specific gravity is so much less, it covers equally well one-third more surface, by which a great saving is effected; a similar economy arises from its use in steam and gas joints, for which purpose it is superior to white lead.

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UNION WATER-METER CO., LIMITED.

The above Company, having purchased the patent rights of the Union Water-Meter, are prepared to receive and execute orders for their Patent Positive Meters, which are simple and compact.

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THE

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[KIRKHAM, HULETT, AND CHANDLER'S PATENT.]

Some of the advantages claimed for this Apparatus are as follow:—

The Exposing of a large Amount of Effectually-wetted Surface (which is continually reproduced) to act upon the Gas.

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Saving of Expense in Providing and Exchanging Scrubbing Material—none being required.

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It works without Pressure.

It is particularly adapted for Gas-Works where Sulphate of Ammonia is manufactured.

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IMPERIAL METER COMPANY,

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OFFICE: 115, VICTORIA STREET, WESTMINSTER, S.W.,

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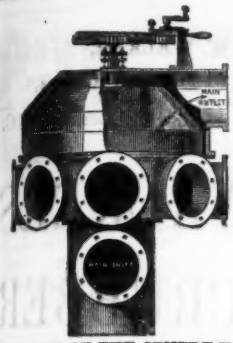
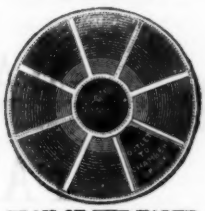
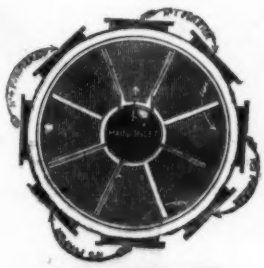
Attention is called to their Dry Meters in Wood Cases, as used by the principal London Gas Companies. These Meters are especially suitable for seaport towns and for export.

The Company repair or convert every description of Wet Gas-Meters to De Castro and Burton's Patent.



C. & W. WALKERS'
PATENT CENTRE-VALVES.





ELEVATION OF THE CENTRE-VALVE. PLAN OF THE VALVE. PLAN OF THE BODY.

These PATENT CENTRE-VALVES are the most perfect and certain means for working Purifiers on the system of three in action, and one out of action. The Valve itself is protected from all injury inside the safety cover. The working of the Valve is so easy, and so governed by the stop-catch movement, that the Purifiers can be instantaneously changed in the dark as well as in daylight. They are scraped perfectly true, metal to metal, the facings heretofore exposed are always covered, and there is nothing more reliable, certain, and durable in a gas-works. By their use the floor of the Purifying-house is clear and level; the Valve and all connexions being beneath the floor, out of the way of working. A considerable improvement and saving is effected in the cost of the connecting-pipes.

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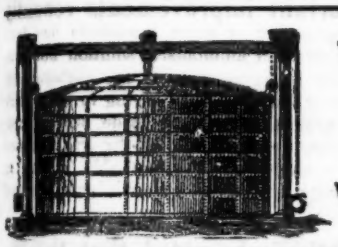

W. C. HOLMES & CO.,

WHITESTONE IRON-WORKS, HUDDERSFIELD,

MANUFACTURERS OF

RETORTS, ANNULAR AND PIPE CONDENSERS,
WROUGHT AND CAST IRON SCRUBBERS, PURIFIERS,
GASHOLDERS,

GOVERNORS, AND ALL THE NECESSARY FITTINGS FOR COMPLETING THE ERECTION OF GAS-WORKS.

STATION & CONSUMERS WET OR DRY METERS, STREET & SERVICE MAINS, LAMP COLUMNS & BRACKETS, & WROUGHT-IRON TUBES AND FITTINGS; WROUGHT-IRON ROOFS FOR ANY SIZE OF BUILDINGS.

Sole Makers of B. W. Thurston's Combined Condensing, Scrubbing, and Washing Apparatus,

AND PATENTEES OF THE IMPROVED COMBINED CONDENSING AND PURIFYING APPARATUS SO EMINENTLY ADAPTED FOR EXPORTATION.

REFERENCES TO UPWARDS OF 300 GAS-WORKS.

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FLETCHER AND MURPHY,

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Manufacturers of

IMPROVED CONSUMERS WET GAS-METERS

IN CAST-IRON CASES,

THE UNVARYING WATER-LINE GAS-METER,

AND

IMPROVED DRY GAS-METERS;

STATION-METERS OF ALL SIZES, with PLANED JOINTS;

GOVERNORS, PRESSURE AND EXHAUST REGISTERS, TEST HOLDERS.

And all kinds of Experimental Gas Apparatus.

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IMPROVED CENTRE-VALVES,

PURIFIERS, CONDENSERS, SCRUBBERS, GASHOLDERS, ROOFS,

And every description of Gas Machinery.

TENDERS GIVEN FOR WORK FIXED COMPLETE IN ANY PART OF THE KINGDOM.

C. & W. WALKER,
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LONDON, E.C.

MANN & WALKERS' PATENT SCRUBBER.

By Letters Patent in Great Britain, Europe, and the United States of America.

By some important improvements recently patented, the purifying power of these Scrubbers has been much increased, and a stronger ammoniacal solution obtained, which is found to absorb a large portion of the carbonic acid contained in gas, effecting an important saving in money and labour in the lime purifiers, and where oxide only is used, the increase in the illuminating power of the gas obtained by these Scrubbers is shown in a remarkable degree, in consequence of the large quantity of carbonic acid removed from the gas.

It is to be particularly noted that the important results of these Scrubbers do not depend upon the machinery alone. The entire internal construction of the Scrubber bears an almost equally important part. For this reason, where it is desirable to convert existing Scrubbers, whose dimensions happen to be suitable, the work commences by ripping out the whole of the interior of the shell, and beginning the internal construction *de novo* from bottom to top.

Fifty million cubic feet of gas per 24 hours are purified from ammonia by these Patent Scrubbers in a winter's day in the gas-works of London, where the purity of gas supply is the highest in the world, under the chemical restrictions of the Board of Trade.

Generally, wherever a high standard of purification is maintained in the chief cities and towns of the British Provinces and of Europe, these Scrubbers have become established.

By their use the department of purification from ammonia upon a gas-works is made complete, without the aid of prepared oxide of iron, chemicals in purifiers, or any other supplementary process, and the whole ammoniacal residual product contained in the coal is absorbed and obtained in the form most profitable to a gas company, while the requirements of all Acts of Parliament and of the Board of Trade, relating to incorporate gas companies, are satisfied.

Foul Gas, properly condensed, entering the inlet is, by once only passing through the Scrubber, completely purified from ammonia with regular certainty day by day, without any further trouble, or any other process, effected by a very small quantity of clear water let into the machinery room at the top of the Scrubber, which is discharged at the liquor outlet at the bottom, from Newcastle coal at about 18 to 20 ounces strength, from Yorkshire and other coals, generally from 25 to 30 ounces strength; while acidulated litmus or turmeric exposed at the Scrubber outlet will not show the slightest discoloration, and there is not a quarter of a grain of ammonia per 100 feet left unabsorbed.

They contain their own engine power, requiring only a small inappreciable quantity of steam from the gas-works boiler, and are then complete in themselves, ready for service.

Applications relating to dimensions and prices should be addressed to us, C. AND W. WALKER, 8, FINSBURY CIRCUS, LONDON, E.C., or to Mr. WILLIAM MANN, late Superintendent of the Chartered Gas-Works, BLACKFRIARS, LONDON; they should state approximately the largest make of gas in 24 hours on a winter's day, and the smallest make on a summer's day, to be purified.

ALDER AND MACKAY,

GRANGE WORKS, EDINBURGH,

MANUFACTURERS OF

CONSUMERS IMPROVED GAS-METERS;

IMPROVED DRY GAS-METERS, in Cast-Iron and Tin Cases,

OF THE HIGHEST EXCELLENCE,

Warranted to measure correctly, and not to vary.

STATION METERS AND GOVERNORS,

EXPERIMENTAL METERS, PHOTOMETERS, GASHOLDERS, &c.

WILLEY & COMPANY,

GAS ENGINEERS,

WORKS: COMMERCIAL ROAD, EXETER,

INVITE THE ATTENTION OF GAS COMPANIES AND OTHERS FOR THE SUPPLY OF

EVERY DESCRIPTION OF GAS APPARATUS.

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NEW GAS-WORKS erected complete. Plans and Estimates furnished. MAINS, METERS, SERVICES, LAMPS, &c., adapted for Towns of any size. Gas Companies advised on Improvements, Extensions, and Alterations of Works.

GASHOLDERS AND TANKS.

RETORTS and RETORT-HOUSE FITTINGS, CONDENSERS, SCRUBBERS, ENGINES and EXHAUSTERS, PURIFIERS, STATION-METERS, GOVERNORS, VALVES, &c.

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They beg special attention to the excellence and superiority of their WET and DRY METERS, several thousand being now in use by many of the largest Gas Companies in the West of England and South Wales. Warranted to measure correctly, and not to vary. Their acknowledged superiority has brought them into general use more rapidly than any Meters hitherto manufactured. A guarantee of Five years tendered with each Meter.

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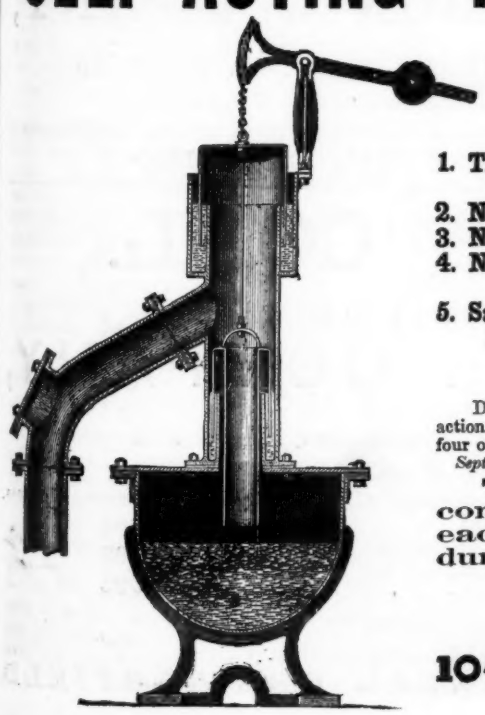
An extensive variety of Choice Designs in CHANDELIERS, PENDANTS, BRACKETS, STAR and SUN LIGHTS, MEDIÆVAL FITTINGS for CHURCHES, &c.

PATTERN-BOOKS and PRICE LISTS furnished.

☞ PLEASE NOTE THE ADDRESS—

GAS ENGINEERING WORKS, COMMERCIAL ROAD, EXETER.

SELF-ACTING REMOVABLE DIP-PIPE,



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CHANDLER & STEVENSON.

ADVANTAGES.

1. There is no pressure on the Retorts.
2. No deposit of Carbon.
3. No scurfing is required.
4. Never a choked Ascension-Pipe.
5. Saves Fuel and Wear and Tear.
6. Gets 10 per cent. more Gas out of the Coal, and a higher Illuminating Power.
7. Is never out of order.
8. Requires no attention.
9. Is perfectly automatic in its action.

Testimonial from the Proprietor of the Apeldorn Gas-Works.

DEAR SIR,—In reply to your inquiry, the Self-Acting Dip-Pipes, which have been in action at my works for two years, give entire satisfaction. I forward you order for four others.

Yours truly,

Sept. 9, 1877. R. BAKER.

These Dip-Pipes can now be supplied complete, except the flanched bend, for £4 each, which includes the charge for licence during the whole term of the patent.

APPLICATIONS TO BE MADE TO

Messrs. CHANDLER & SONS,

104, NEWINGTON CAUSEWAY, S.E.,

Who fix the Dip-Pipes, at a small Charge, when required.

ROBERT MARSHALL,

CANNEL COAL MERCHANT,

198, ST. VINCENT STREET, GLASGOW.

SHOTT'S BOGHEAD.

LOTHIAN'S CANNEL

Yields 12,500 cubic feet of 24-candle gas per ton, and 9 cwts. of excellent coke, containing only 4 per cent. of ash.

MUIRKIRK, No. 1, CANNEL

Yields 12,160 cubic feet of 32·5-candle gas per ton, and 10 cwts. of excellent coke, containing only 5 per cent. of ash.

OLD WEMYSS CANNEL

Yields 13,220 cubic feet of 32·5-candle gas per ton.

Prices and full Analyses on application.

GAS COAL.

POPE & PEARSON, LIMITED, have now the authority of several of the most eminent Gas Engineers of London in stating that their Coal yields *in practical working over 10,000 cubic feet of gas, with an illuminating power of 16 candles;* or by the standard burners now used by the London Gas Companies, an illuminating power equal to 17½ candles.

One ton yields 12½ cwt. of good coke. This Coal can be shipped from Hull, Goole, Liverpool, Morecambe, and Barrow.

For further particulars, apply to POPE AND PEARSON, LIMITED, West Riding and Silkstone Collieries, near LEEDS.

SCOTCH CANNEL COALS.

The Subscriber is prepared to contract for the supply of all the principal SCOTCH CANNEL COALS. Prices and Analyses of the various Coals will be forwarded on application.

JAMES M'KELVIE,

CANNEL COAL MERCHANT,

HAYMARKET, EDINBURGH.

Established 1840.

HEBBURN MAIN GAS COALS.

T. Stone, Esq., of Weymouth, writes on Nov. 17, 1876: "I have used about 12,000 tons of this Coal, with, I think, the best possible results, although not always under the most favourable circumstances. My Coal account made up to Midsummer last showed a makeage of 10,524 cubic feet per ton of 14½-candle gas, and not a hundredweight of Cannel used. This statement would, I know, be incredible to many men, and may provoke the remark, 'How much of it is paid for?' For the gratification of such, I have to say that, of the above quantity, 9866 cubic feet per ton of Coal carbonized were brought to charge and duly paid for, with the exception of about 6s. per cent. for bad debts. The coke is of excellent quality. The above facts I hold to be a greater recommendation to your Coal than any words of mine could be."

PRICES ON APPLICATION, EITHER F.O.B. OR BY RAIL IN TRUCK LOADS.

THE TYNE COAL COMPANY, LIMITED, OWNERS.
W. RICHARDSON, Fitter,
29, QUAYSIDE, NEWCASTLE-ON-TYNE.

LESMAHAGOW CANNEL COAL.

FERRAND DAVIES,

148, GRESHAM HOUSE, OLD BROAD STREET, LONDON, E.C.,

SOLE AGENT FOR

THOMAS BARR'S LESMAHAGOW MAIN CANNEL.

Quotation and Analysis forwarded on application.

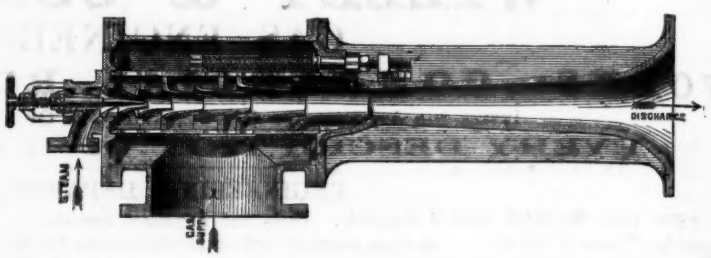
MIDLAND & YORKSHIRE COMPANY,

COAL OWNERS AND FACTORS,

Supply to any Railway Station the best descriptions of Gas Coal, Nuts, and Cannel.

PRICES ON APPLICATION.

HEAD OFFICE: 79, MARK LANE, LONDON.



KÖRTING'S STEAM-JET GAS-EXHAUSTER.

IMPROVED CLELAND'S PATENT.

UPWARDS OF 250 IN USE.

CLELAND'S PATENT CONDENSER AND STEAM SCRUBBER.

FOR PARTICULARS, APPLY TO

KÖRTING BROS.,

17, LANCASTER AVENUE, MANCHESTER,

OR TO

GERALD J. TUPP, 8, John Street, Adelphi, W.C., LONDON,

SOLE AGENT FOR ENGLAND AND WALES.

THE WIGAN COAL & IRON COMPANY,

LIMITED.

DISTRICT OFFICE: 97, NEW STREET, BIRMINGHAM; AGENT: W. M'GOWAN;

Supply the Best Wigan Arley Mine Gas Coal, Gas Nuts, Gas Cannel, &c.

N.B.—The Wigan Coal and Iron Company, Limited, are exclusive owners of the well-known HAIGH HALL AND KIRKLESS HALL GAS COAL COLLIERIES.

ALBERT GAS COAL.

THE DERBYSHIRE

SILKSTONE COAL COMPANY,

LIMITED,

CAN OFFER A

GAS COAL

Of superior quality, delivered in trucks at any Railway Station in England, or shipped on board at Hull, Grimsby Docks, or Barrow-in-Furness.

Purified gas per ton of coal in cubic feet (average)	10,262
Illuminating power in candles	15·86
Weight of coke in lbs. per ton of coal	1,502

ANALYSIS AND PRICES ON APPLICATION TO

Mr. EDMUND TAYLOR, Secretary,

ALBERT COLLIERY, NEWBOLD, NEAR CHESTERFIELD.

THE SILKSTONE & DODWORTH COAL & IRON COMPANY, LIMITED,

DODWORTH, BARNSLEY.

BENJAMIN WHITWORTH, Esq., M.P. . . . . Chairman.
Mr. RICHARD HARTLEY . . . . . Managing Director.

REAL OLD SILKSTONE GAS COAL.

JAMES PATERSON, Esq., Gas Engineer, of the Warrington Gas Company, reported, Aug. 10, 1875:—

"This Coal possesses remarkable qualities as a gas and coking coal, and appears SECOND TO NONE IN THE KINGDOM. It contains the large quantity of 699 lbs. of illuminating matter, and 1498 lbs. of coke to the ton, and produces **12,240** cubic feet of 16·66 candle gas."

The above Company are raising nearly a thousand tons of the Real Old Silkstone Gas Coal per working day.

PRICES QUOTED TO ANY RAILWAY STATION, OR F.O.B. HULL, GRIMSBY, GOOLE, KEADBY, LIVERPOOL, AND FLEETWOOD.

HYDRATED PURIFYING MATERIAL.

Samples on application.

MESSRS. SPENCE BROS., LIMITED,

Will be glad to supply the above on the most favourable terms,

And to treat, by Purchase or Exchange, for Spent Oxide.

PRICES ON APPLICATION.

ALSO PATENT DRY COPPERAS FOR EXTRACTING AMMONIA.

VICTORIA CHEMICAL WORKS, BRADFORD, NEAR MANCHESTER.

Established

1795.

JOSEPH CLIFF & SONS,

THE ORIGINAL

WORTLEY FIRE-BRICK WORKS,

NEAR LEEDS,

London Wharf: No. 4, inside Great Northern Goods Station, King's Cross, N.;

LIVERPOOL: Back Leeds Street.

SPECIAL NOTICE.—Our Patent Machine-made Retorts have now been in *actual work* nearly 1000 days, and are yet in good order. References on application.

July 2, 1877.

NEWTON, CHAMBERS, & CO.,

THORNCLIFFE IRON-WORKS AND COLLIERIES,

NEAR SHEFFIELD.

CELEBRATED SILKSTONE GAS COALS.

The various descriptions of Gas Coal produced from the above Collieries possess an unequalled reputation, combining in a large degree the constituents essential for the production of the best quality of Coke and Gas of a high illuminating power.

A recent extensive development of the Collieries enables us to offer increased supplies.

JAS. PATERSON, Esq., of Warrington, after testing various qualities of our Coal, has sent the following testimony of their merits:—

"*Warrington Gaslight and Coke Company,*
Offices, Mersey Street, Warrington, April 23, 1877.

"MESSRS. NEWTON, CHAMBERS, AND CO.,

"GENTLEMEN,—After carefully testing the various samples of Gas Coals sent from your Collieries for analysis, I have pleasure in reporting them as belonging to the highest class of Gas and Coking Coals.

"The average of Nine samples gives a yield of **12,500** cubic feet of **15½**-Candle Gas, being equivalent to **664** lbs. of sperm per ton, and **1420** lbs. of fixed carbon of a very superior quality. All the samples bear a close relation to each other in value.

"Yours truly, "JAMES PATERSON."

Full particulars will be sent on application to us—address as above.

CROLL'S
DRY GAS-METERS,

PRIZE MEDALS.

LONDON, 1851;
NEW YORK, 1853
PARIS, 1855.

(INVENTED & PATENTED IN 1844,)

COMBINING ALL THE LATEST IMPROVEMENTS,

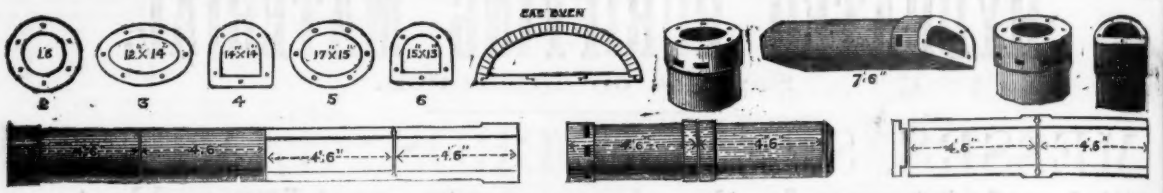
MANUFACTURED ONLY BY

PRIZE MEDALS

LONDON 1862;
DUBLIN, 1865;
PARIS, 1867

THE GAS-METER COMPANY, LIMITED,

238, KINGSLAND ROAD, LONDON, N.E.



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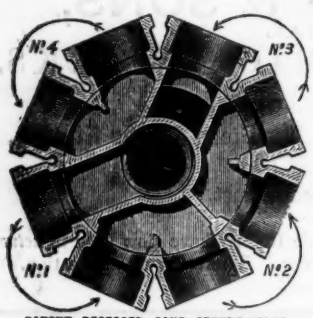

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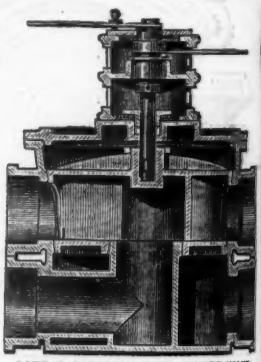
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Which are so constructed that neither putty nor other materials are required to secure the glass. No hacking out of old putty, which frequently destroys the frames. A new pane of glass can be inserted in two or three minutes by any inexperienced person, the glass being secured by a hinged flap and turn button.

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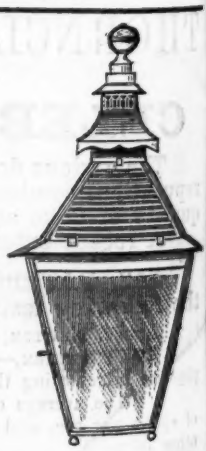

55 and 56, HIGH HOLBORN, LONDON.

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